

Natural Gas & Propane Modulating & Condensing Hot Water Boiler Models:

- BMK 750
- BMK 1000

Applicable to Serial Numbers:

• **G-14-0752** and above

USER MANUAL

Installation, Operation and Maintenance

BENCHMARK Series Gas-Fired Boilers



Latest Update: 05/21/2014







Technical Support (Mon-Fri, 8am-5pm EST) 1-800-526-0288 www.aerco.com

Disclaimer

The information contained in this manual is subject to change without notice from AERCO International, Inc. AERCO makes no warranty of any kind with respect to this material, including but not limited to implied warranties of merchantability and fitness for a particular application. AERCO International is not liable for errors appearing in this manual. Nor for incidental or consequential damages occurring in connection with the furnishing, performance, or use of this material.

TABLE OF CONTENTS

FOREWORD	7
CHAPTER 1. SAFETY PRECAUTIONS	11
1.1 WARNINGS & CAUTIONS	11
1.2 EMERGENCY SHUTDOWN	12
1.3 PROLONGED SHUTDOWN	
CHAPTER 2. INSTALLATION	15
2.1 INTRODUCTION	15
2.2 RECEIVING THE UNIT	15
2.3 UNPACKING	15
2.4 SITE PREPARATION	16
2.4.1 Installation Clearances	16
2.4.2 Setting the Unit	
2.5 SUPPLY AND RETURN PIPING	
2.6 PRESSURE RELIEF VALVE INSTALLATION	
2.7 CONDENSATE DRAIN & PIPING	20
2.8 GAS SUPPLY PIPING	22
2.8.1 Gas Supply Specifications	22
2.8.2 Manual Gas Shutoff Valve	23
2.8.3 External Gas Supply Regulator	23
2.8.3.1 Massachusetts Installations Only	
2.8.3.2 All Installations (Except Massachusetts)	
2.9 AC ELECTRICAL POWER WIRING	24
2.9.1 Electrical Power Requirements	25
2.10 FIELD CONTROL WIRING	26
2.10.1 OUTDOOR AIR IN Terminals	28
2.10.2 COMBUSTION AIR Terminal	29
2.10.3 O ₂ SENSOR Terminals	
2.10.4 SPARK SIGNAL Terminals	29
2.10.5 ANALOG IN Terminals	
2.10.6 B.M.S. (PWM) IN Terminals	29
2.10.7 SHIELD Terminals	29
2.10.8 ANALOG OUT Terminals	30
2.10.9 RS-485 Comm Terminals	30
2.10.10 RS-232 Comm Terminals	30
2.10.11 VFD/Blower (0-10 & AGND)	30
2.10.12 Interlocks	
2.10.12.1 REMOTE INTL'K Terminals	30
2.10.12.2 DELAYED INTL'K Terminals (OUT & IN)	30
2.10.13 FAULT RELAY (NC, COM, & NO) Terminals	
2.10.14 AUX RELAY CONTACTS (NC, COM, & NO) Terminals	31
2.11 FLUE GAS VENT INSTALLATION	
2.12 COMBUSTION AIR	32
2.12.1 Combustion From Outside the Building	32

2.12.2 Combustion Air from Inside the Building	32
2.13 DUCTED COMBUSTION AIR	
2.14 BENCHMARK PUMP RELAY OPTION	
2.15 SEQUENCING ISOLATION VALVE INSTALLATION	
CHAPTER 3. OPERATION	27
3.1 INTRODUCTION	
3.2 CONTROL PANEL DESCRIPTION	
3.3 CONTROL PANEL DESCRIPTION	
3.3.1 Menu Processing Procedure	
3.5 SETUP MENU	
3.7 TUNING MENU	
3.8 COMBUSTION CAL MENU	
3.9 BST (Boiler Sequencing Technology) Menu	
3.10 START SEQUENCE	
3.11 START/STOP LEVELS	53
CHAPTER 4. INITIAL START-UP	
4.1 INITIAL START-UP REQUIREMENTS	
4.2 TOOLS AND INSTRUMENTATION FOR COMBUSTION CALIBRATION	55
4.2.1 Required Tools & Instrumentation	56
4.2.2 Installing Gas Supply Manometer	56
4.2.3 Accessing the Analyzer Probe Port	57
4.3 NATURAL GAS COMBUSTION CALIBRATION	58
4.4 PROPANE COMBUSTION CALIBRATION	61
4.5 REASSEMBLY AFTER COMBUSTION CALIBRATION	64
4.6 OVER-TEMPERATURE LIMIT SWITCHES	65
4.6.1 Digital Alarm Switch Checks and Adjustments	66
CHAPTER 5. MODE OF OPERATION	69
5.1 INTRODUCTION	
5.2 INDOOR/OUTDOOR RESET MODE	
5.2.1 Reset Ratio	
5.2.2 Building Reference Temperature	
5.2.3 Outdoor Air Temperature Sensor Installation	
5.2.4 Indoor/Outdoor Startup	
5.3 CONSTANT SETPOINT MODE	
5.3.1 Setting the Setpoint	
5.4 REMOTE SETPOINT MODES	
5.4.1 Remote Setpoint Field Wiring	
5.4.2 Remote Setpoint Startup	
5.5 DIRECT DRIVE MODES	
5.5.1 Direct Drive Field Wiring	
5.5.2 Direct Drive Startup	
5.6 AERCO CONTROL SYSTEM (ACS)	
5.5 / 12.100 601411102 51512111 (/165/	

5.6.1 ACS External Field Wiring	74
5.6.2 ACS Setup and Startup	74
5.7 COMBINATION CONTROL SYSTEM (CCS)	74
5.7.1 Combination Control System Field Wiring	75
5.7.2 Combination Control System Setup and Startup	75
CHAPTER 6. SAFETY DEVICE TESTING	77
6.1 TESTING OF SAFETY DEVICES	77
6.2 LOW GAS PRESSURE FAULT TEST	78
6.3 HIGH GAS PRESSURE TEST	79
6.4 LOW WATER LEVEL FAULT TEST	80
6.5 WATER TEMPERATURE FAULT TEST	81
6.6 INTERLOCK TESTS	82
6.6.1 Remote Interlock Test	82
6.6.2 Delayed Interlock Test	
6.7 FLAME FAULT TESTs	83
6.8 AIR FLOW FAULT TESTS	
6.8.1 Blower Proof Switch Test	
6.8.2 Blocked Inlet Switch Test	
6.9 SSOV PROOF OF CLOSURE SWITCH	
6.10 PURGE SWITCH OPEN DURING PURGE	
6.11 IGNITION SWITCH OPEN DURING IGNITION	
6.12 SAFETY PRESSURE RELIEF VALVE TEST	88
CHAPTER 7. MAINTENANCE	89
7.1 MAINTENANCE SCHEDULE	
7.2 IGNITER-INJECTOR REPLACEMENT	90
7.3 FLAME DETECTOR REPLACEMENT	92
7.4 O ₂ SENSOR REPLACEMENT	93
7.5 COMBUSTION CALIBRATION	93
7.6 SAFETY DEVICE TESTING	93
7.7 BURNER ASSEMBLY INSPECTION	93
7.8 CONDENSATE DRAIN TRAP MAINTENANCE	96
7.9 AIR FILTER CLEANING & REPLACEMENT	
7.10 SHUTTING THE BOILER DOWN FOR AN EXTENDED PERIOD OF TIME	99
7.11 PLACING THE BOILER BACK IN SERVICE AFTER A PROLONGED SHUTDOWN	99
CHAPTER 8. TROUBLESHOOTING GUIDE	101
8.1 INTRODUCTION	
8.2 ADDITIONAL FAULTS WITHOUT SPECIFIC FAULT MESSAGES	113
CHAPTER 9. RS-232 COMMUNICATION	117
9.1 INTRODUCTION	
9.1.1 Aquiring the PuTTY Application	
9.1.2 Logging on to a Remote Machine Using PuTTY	
9.1.3 Running a Command on a Remote Machine Using PuTTY	
9.2 RS-232 COMMUNICATION SETUP	

9.3 MENU PROCESSING UTILIZING RS-232 COMMUNICATION	.119
9.4 DATA LOGGING	
9.4.1 Fault Log	.120
9.4.2 Operation Time Log	.121
9.4.3 Sensor Log	.122
CHAPTER 10. BOILER SEQUENCING TECHNOLOGY	123
10.1 INTRODUCTION	
10.2 AERCO BST Quick Start Chart	_
10.3 BST Implementation Instruction	
10.3.1 Option 1 - Constant Setpoint with DIRECT Wired Header Sensor	
10.3.2 Option 2 - Constant Setpoint with MODBUS Wired Header Sensor	
10.3.3 Option 3 - Outdoor Reset with DIRECT WIRED Header Sensor AND DIRECT WIRED Outdoor	
Sensor	
10.3.4 Option 4 - Outdoor Reset with MODBUS Header Sensor AND MODBUS Outdoor Sensor	
10.3.5 Option 5 - Remote Setpoint with DIRECT WIRED Header Sensor AND 4-20ma Setpoint Dri	
10.3.6 Option 6 - Remote Setpoint with DIRECT WIRED Header Sensor AND MODBUS Setpoint D	
	. 133
10.3.7 Option 7 - Remote Setpoint with MODBUS Header Sensor AND 4-20ma Setpoint Drive	. 134
10.3.8 Option 8 - Remote Setpoint with MODBUS Header Sensor AND MODBUS Setpoint Drive	. 136
APPENDIX A: BOILER MENU ITEM DESCRIPTIONS	. 139
APPENDIX B: STARTUP, STATUS & DISPLAY MESSAGES	. 145
APPENDIX C: SENSOR RESISTANCE/VOLTAGE CHART	
APPENDIX D – INDOOR/OUTDOOR RESET RATIO CHARTS	. 151
APPENDIX E – BOILER DEFAULT SETTINGS	. 155
APPENDIX F – DIMENSIONAL DRAWINGS	. 157
APPENDIX G – PART LIST DRAWINGS	.161
APPENDIX H – PIPING DRAWINGS	. 171
APPENDIX I – C-MORE WIRING DIAGRAMS	.175
APPENDIX J – RECOMMENDED PERIODIC TESTING	.179
APPENDIX K – C-MORE CONTROL PANEL VIEWS	.181
APPENDIX L: RECOMMENDED SPARES	. 183
APPENDIX M – ULTRA-LOW NOx CALIBRATION	. 185
LINAITED MAADDANITY	100

FOREWORD

The AERCO Benchmark (BMK) 750 and 1000 MBH Boilers are modulating and condensing units. They are a true industry advancement that meets the needs of today's energy and environmental concerns. Designed for application in any closed loop hydronic system, the Benchmark's modulating capability relates energy input directly to fluctuating system loads. The maximum turn down ratios for the BMK 1000 and BMK 750 are 20:1 and 15:1, respectively. Both BMK models provide extremely high efficiencies and make them ideally suited for modern low temperature, as well as, conventional heating systems.

The Benchmark Models BMK 750 and BMK 1000 operate within the following input and output ranges:

	Input Range (BTU/hr.)		Output Range	e (BTU/hr.)
Benchmark Model	Minimum	Maximum	Minimum	Maximum
BMK 750	50,000	750,000	47750	716,250
BMK 1000	50,000	1,000,000	48300	968,000

The output of each boiler model is a function of the unit's firing rate (valve position) and return water temperature.

When installed and operated in accordance with this Instruction Manual, the BMK 750 and BMK 1000 MBH Boilers comply with the NOx emission standards outlined in:

• South Coast Air Quality Management District (SCAQMD), Rule 1146.2

Whether used in singular or modular arrangements, the BMK 750 and BMK 1000 offer the maximum venting flexibility with minimum installation space requirements. These Boilers are Category II, III and IV, positive pressure appliances. Single and/or multiple breeched units are capable of operation in the following vent configurations:

- Conventional, Vertical
- Conventional, Sidewall
- Conventional, Direct Vent, Vertical
- Sealed, Direct Vent, Horizontal

These boilers are capable of being vented utilizing PVC, CPVC, Polypropylene and AL29-4C vent systems.

The Benchmark's advanced electronics are available in several selectable modes of operation offering the most efficient operating methods and energy management system integration.

IMPORTANT

Unless otherwise specified, all descriptions and procedures provided in this Installation, Operation & Maintenance Manual apply to both Benchmark 750 MBH and Benchmark 1000 MBH boilers.

Phrases, Abbreviations and Acronyms

Phrase, Abbreviation or Acronym	Meaning	
A (Amp)	Ampere	
ACS	AERCO Control System, AERCO's boiler management systems	
ADDR	Address	
AGND	Analog Ground	
ALRM	Alarm	
ASME	American Society of Mechanical Engineers	
AUX	Auxiliary	
BAS	Building Automation System, often used interchangeably with EMS (see below)	
Baud Rate	Symbol rate, or simply the number of distinct symbol changes (signaling events) transmitted per second. It is not equal to bits per second, unless each symbol is 1 bit long.	
BMK	Benchmark series boilers	
BMS or BMS II	AERCO Boiler Management Systems	
BLDG (Bldg)	Building	
BST	AERCO on-board Boiler Management Technology	
вти	British Thermal Unit. A unit of energy approximately equal to the heat required to raise 1 pound of water 1° F.	
CCP	Combustion Control Panel	
C-More Controller (or Control Box)	A control system developed by AERCO and currently used in all Benchmark, Innovation and KC1000 Series product lines.	
CO	Carbon Monoxide	
COMM (Comm)	Communication	
BTU	British Thermal Unit. A unit of energy approximately equal to the heat required to raise 1 pound of water 1° F.	
Cal.	Calibration	
CNTL	Control	
DBB	Double Block and Bleed. Used to define boiler gas trains containing 2 Safety Shutoff Valves (SSOVs) and a solenoid operated vent valve. Also known as IRI gas trains (see below)	
DIP	Dual In-Line Package	
EMS	Energy Management System; often used interchangeably with BAS	
FM	Factory Mutual. Used to define boiler gas trains.	
GND	Ground	
HDR	Header	
Hex	Hexadecimal Number (0 – 9, A – F)	
HX	Heat Exchanger	
Hz	Hertz (Cycles Per Second)	
I.D.	Inside Diameter	
IGN	Ignition	
IGST Board	Ignition/Stepper Board contained in C-More Control Box	

Phrases, Abbreviations and Acronyms - Continued

Phrase, Abbreviation or Acronym	Meaning	
INTLK (INTL'K)	Interlock	
I/O	Input/Output	
I/O Box	Input/Output (I/O) Box currently used on Benchmark, Innovation and KC1000 Series products	
IP	Internet Protocol	
IRI	Industrial Risk Insurers. A now discontinued code used to define gas trains containing two SSOVs and a solenoid operated vent valve.	
ISO	Isolated	
LED	Light Emitting Diode	
LN	Low NOx	
MA (mA)	Milliampere (1 thousand th of an ampere)	
MAX (Max)	Maximum	
MIN (Min)	Minimum	
Modbus®	A serial, half-duplex data transmission protocol developed by AEG Modicon	
NC (N.C.)	Normally Closed	
NO (N.O.)	Normally Open	
NOx	Nitrogen Oxide	
NPT	National Pipe Thread	
O ₂	Oxygen	
O.D.	Outside Diameter	
PMC Board	A Primary Micro-Controller (PMC) board is contained in the C-More Control Box used on all Benchmark units.	
PPM	Parts Per Million	
PTP	Point-to-Point (usually over RS-232 networks)	
PWM	Pulse Width Modulation	
REF (Ref)	Reference	
RES.	Resistive	
RS-232 (or EIA-232)	A standard for serial, full-duplex (FDX) transmission of data based on the RS-232 Standard	
RS-422 (or EIA-422)	A standard for serial, full-duplex (FDX) transmission of data based on the RS-422 Standard	
RS-485 (or EIA-485)	A standard for serial, half-duplex (HDX) transmission of data based on the RS-485 Standard	
RTN (Rtn)	Return	
SETPT (Setpt)	Setpoint Temperature	
SHLD (Shld)	Shield	
SSOV	Safety Shut Off Valve	
TEMP (Temp)	Temperature	
1/	•	

Phrases, Abbreviations and Acronyms - Continued

Phrase, Abbreviation or Acronym	Meaning
Terminating Resistor	A resistor placed at each end of a daisy-chain or multi-drop network in order to prevent reflections that may cause invalid data in the communication
VDC	Volts, Direct Current
VFD	Vacuum Fluorescent Display, or Variable Frequency Drive
W	Watt
W.C.	Water Column
μΑ	Micro amp (1 million th of an ampere)

CHAPTER 1. SAFETY PRECAUTIONS

1.1 WARNINGS & CAUTIONS

Installers and operating personnel MUST, at all times, observe all safety regulations. The following warnings and cautions are general and must be given the same attention as specific precautions included in these instructions. In addition to all the requirements included in this AERCO Instruction Manual, the installation of units MUST conform with local building codes, or, in the absence of local codes, ANSI Z223.1 (National Fuel Gas Code Publication No. NFPA-54) for gas-fired boilers and ANSI/NFPASB for LP gas-fired boilers. Where applicable, the equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CSA B149.1, and applicable Provincial regulations for the class; which should be carefully followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

See pages 13 and 14 for important information regarding installation of units within the Commonwealth of Massachusetts.

IMPORTANT

This Instruction Manual is an integral part of the product and must be maintained in legible condition. It must be given to the user by the installer and kept in a safe place for future reference.

△ WARNING **△**

DO NOT USE MATCHES, CANDLES, FLAMES, OR OTHER SOURCES OF IGNITION TO CHECK FOR GAS LEAKS.

△ WARNING **△**

FLUIDS UNDER PRESSURE MAY CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT WHEN RELEASED. BE SURE TO SHUT OFF ALL INCOMING AND OUTGOING WATER SHUTOFF VALVES. CAREFULLY DECREASE ALL TRAPPED PRESSURES TO ZERO BEFORE PERFORMING MAINTENANCE.

\triangle <u>warning</u> \triangle

BEFORE ATTEMPTING TO PERFORM ANY MAINTENANCE ON THE UNIT, SHUT OFF ALL GAS AND ELECTRICAL INPUTS TO THE UNIT.

<u>MARNING</u> <u>M</u>

THE EXHAUST VENT PIPE OF THE UNIT OPERATES UNDER A POSITIVE PRESSURE AND THERE-FORE MUST BE COMPLETELY SEALED TO PREVENT LEAKAGE OF COMBUSTION PRODUCTS INTO LIVING SPACES.

<u>MARNING</u> <u>M</u>

ELECTRICAL VOLTAGES UP TO 120 VAC MAY BE USED IN THIS EQUIPMENT. THEREFORE THE COVER ON THE UNIT'S POWER BOX (LOCATED BEHIND THE FRONT PANEL DOOR) MUST BE INSTALLED AT ALL TIMES, EXCEPT DURING MAINTENANCE AND SERVICING.

A DOUBLE-POLE SWITCH MUST BE INSTALLED ON THE ELECTRICAL SUPPLY LINE OF THE UNIT. THE SWITCH MUST BE INSTALLED IN AN EASILY ACCESSIBLE POSITION TO QUICKLY AND SAFELY DISCONNECT ELECTRICAL SERVICE. DO NOT AFFIX SWITCH TO UNIT SHEET METAL ENCLOSURES.

\triangle CAUTION \triangle

Many soaps used for gas pipe leak testing are corrosive to metals. The piping <u>must</u> be rinsed thoroughly with clean water after leak checks have been completed.

\triangle CAUTION \triangle

DO NOT use this boiler if any part has been under water. Call a qualified service technician to inspect and replace any part that has been under water.

1.2 EMERGENCY SHUTDOWN

If overheating occurs or the gas supply fails to shut off, close the manual gas shutoff valve (Figure 1-1) located external to the unit.

NOTF

The Installer must identify and indicate the location of the emergency shutdown manual gas valve to operating personnel.

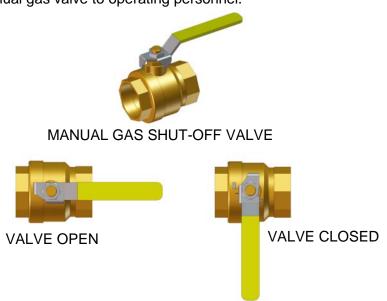


Figure 1-1: Manual Gas Shutoff Valve

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 1 – SAFETY PRECAUTIONS

1.3 PROLONGED SHUTDOWN

After prolonged shutdown, it is recommended that the startup procedures in Chapter 4 and the safety device test procedures in Chapter 6 of this manual be performed to verify all system-operating parameters. If there is an emergency, turn off the electrical power supply to the AERCO boiler and close the manual gas valve located upstream of the unit. The installer must identify the emergency shut-off device.

IMPORTANT – FOR MASSACHUSETTS INSTALLATIONS Boiler installations within the Commonwealth of Massachusetts must conform to the following requirements:

- Boiler must be installed by a plumber or a gas fitter who is licensed within the Commonwealth of Massachusetts.
- Prior to unit operation, the complete gas train and all connections must be leak tested using a non-corrosive soap.
- The vent termination must be located a minimum of 4 feet above grade level. If side-wall venting is used, the installation must conform to the following requirements extracted from 248 CMR 5.08 (2):
- (a) For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:
 - 1. <u>INSTALLATION OF CARBON MONOXIDE DETECTORS</u>. At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.
 - a. In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
 - b. In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.
 - 2. <u>APPROVED CARBON MONOXIDE DETECTORS.</u> Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.
 - 3. <u>SIGNAGE</u>. A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 1 – SAFETY PRECAUTIONS

the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, "GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS".

- 4. <u>INSPECTION</u>. The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.
- (b) EXEMPTIONS: The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:
 - 1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
 - 2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.
- (c) MANUFACTURER REQUIREMENTS GAS EQUIPMENT VENTING SYSTEM PROVIDED. When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:
 - 1. Detailed instructions for the installation of the venting system design or the venting system components; and
 - 2. A complete parts list for the venting system design or venting system.
- (d) <u>MANUFACTURER REQUIREMENTS GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED.</u> When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the flue gases, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:
 - 1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and
 - 2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.
- (e) A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

[End of Extracted Information From 248 CMR 5.08 (2)]

CHAPTER 2. INSTALLATION

2.1 INTRODUCTION

This Chapter provides the descriptions and procedures necessary to unpack, inspect and install AERCO Benchmark Boiler Models BMK 750 and BMK 1000.

2.2 RECEIVING THE UNIT

Each Benchmark Boiler System is shipped as a single crated unit. The shipping weights for the BMK 750 and BMK 1000 Models are approximately 1100 and 1200 pounds, respectively. The unit must be moved with the proper rigging equipment for safety and to avoid equipment damage. The unit should be completely inspected for evidence of shipping damage and shipment completeness at the time of receipt from the carrier and <u>before</u> the bill of lading is signed.

NOTE

AERCO is not responsible for lost or damaged freight. Each unit has a Tip-N-Tell indicator on the outside of the crate. This indicates if the unit has been turned on its side during shipment. If the Tip-N-Tell indicator is tripped, do not sign for the shipment. Note the information on the carrier's paperwork and request a freight claim and inspection by a claims adjuster before proceeding. Any other visual damage to the packaging materials should also be made clear to the delivering carrier.

2.3 UNPACKING

Carefully unpack the unit taking care not to damage the unit enclosure when cutting away packaging materials

After unpacking, closely inspect the unit to make sure there is no evidence of damage not indicated by the Tip-N-Tell indicator. Notify the freight carrier immediately if any damage is detected.

The following accessories come standard with each unit and are either packed separately within the unit's shipping container or are factory installed on the unit:

- Pressure/Temperature Gauge
- ASME Pressure Relief Valve
- Condensate Drain Trap (part no. 24060)
- 1" Gas Supply Shutoff Valve
- Lifting Bar (with attaching hardware)

When optional accessories are ordered, they may be packed within the unit's shipping container, factory installed on the unit, or packed and shipped in a separate container. Any standard or optional accessories shipped loose should be identified and stored in a safe place until ready for installation or use.

2.4 SITE PREPARATION

Ensure that the site selected for installation of the Benchmark Boiler includes:

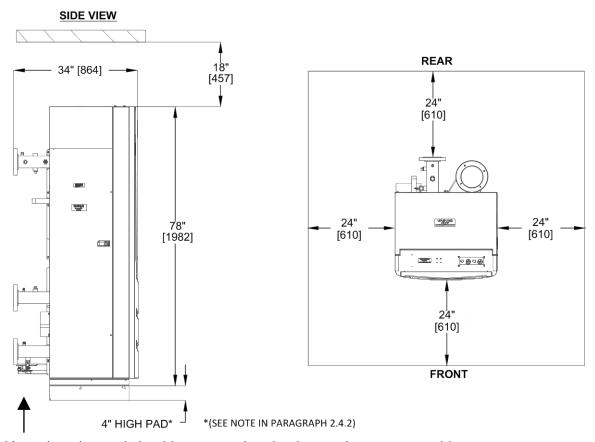
- Access to AC Input Power at 120 VAC, Single-Phase, 60 Hz @ 20 Amps.
- Access to one of the following with the unit operating at maximum capacity:
 - o For Benchmark 750 & 1000, a NATURAL GAS line at a minimum pressure of 4" W.C.
 - o For Benchmark 750, a PROPANE gas line at a minimum pressure of 7" W.C.
 - o For Benchmark 1000, a PROPANE gas line at a minimum pressure of 11" W.C.

2.4.1 Installation Clearances

Benchmark Models 750 and 1000 are packaged in enclosures having identical exterior dimensions. The unit must be installed with the prescribed clearances for service as shown in Figure 2-1a. The <u>minimum</u> clearance dimensions, required by AERCO, are listed below. However, if Local Building Codes require additional clearances, these codes shall supersede AERCO's requirements. Minimum acceptable clearances required are as follows:

Sides: 24 inchesFront: 24 inchesRear: 24 inchesTop: 18 inches

All gas piping, water piping and electrical conduit or cable must be arranged so that they do not interfere with the removal of any panels, or inhibit service or maintenance of the unit.



Housekeeping pad should not extend under the condensate assembly

Figure 2-1a: BMK 750 & 1000 Clearances

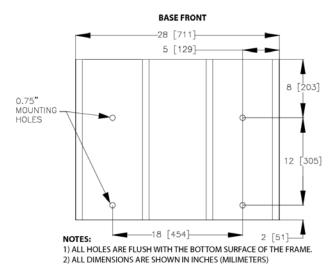


Figure 2-1b: BMK 750 & 1000 Anchor Bolt Locations

KEEP THE UNIT AREA CLEAR AND FREE FROM ALL COMBUSTIBLE MATERIALS AND FLAMMABLE VAPORS OR LIQUIDS.

△ CAUTION **△**

While packaged in the shipping container, the unit must be moved by pallet jack or forklift from the FRONT ONLY.

FOR MASSACHUSSETTS ONLY:

For Massachusetts installations, the unit must be installed by a plumber or gas-fitter licensed within the Commonwealth of Massachusetts. In addition, the installation must comply with all requirements specified in Chapter 1 (Safety Precautions), pages 11 and 12.

2.4.2 Setting the Unit

The unit <u>must</u> be installed on a 4 inch to 6 inch housekeeping pad to ensure proper condensate drainage (see NOTE below). If anchoring the unit, refer to the dimensional drawings in Figure 2-1b for anchor locations.

NOTF

When using the AERCO Condensate Neutralizer Tank for proper condensate drainage, the Neutralizer Tank must be stored in a pit, OR the boiler and AERCO Condensate Trap must be elevated higher than 4" above the floor. See Condensate Tank instructions in TID-0074 for details.

After unpacking and inspecting the boiler, remove the four (4) lag screws securing the boiler to the shipping pallet. The boiler can be lifted and moved by inserting forklift tines in the front slots provided in the base of the unit, or it can be lifted by attaching a lifting bar to the unit's heat exchanger. A lifting bar (59174), with attaching hardware, is supplied with each unit. When shipped, this bar is attached to the rear of the unit as shown in Figure 2-2, View A. One (1)

lifting tab is provided at the top of the unit's heat exchanger as shown. This tab is used to attach the lifting bar to the unit as follows:

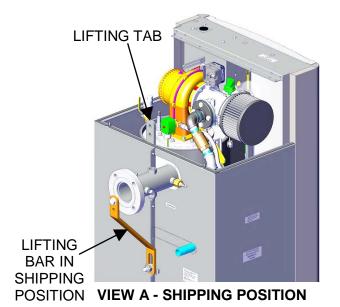
<u>MARNING</u> <u>M</u>

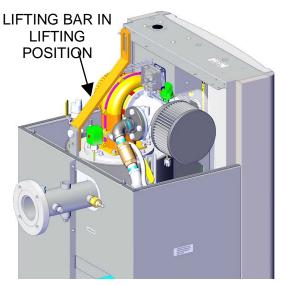
WHEN LIFTING OR MOVING THE BOILER:

- DO NOT ATTEMPT TO MANIPULATE THE BOILER USING THE GAS TRAIN OR BLOWER
- WHEN USING THE LIFTING TAB AND BAR, ENSURE THERE IS NO LOAD PLACED ON THE GAS TRAIN OR BLOWER

Attachment of Lifting Bar

- 1. Remove the lifting bar from its shipping location at the rear of the unit (Figure 2-2, View A). Retain the attaching hardware consisting of two (2) hex head cap screws, hex nuts and flat washers.
- 2. Remove the top shroud from the boiler by grasping the handle on the top of the unit and lifting straight up. Locate the lifting tab at the top-rear of the heat exchanger.
- 3. Refer to Figure 2-2, View B and attach the lifting bar to the heat exchanger lifting tab using the hardware removed in step 1. The upper end of the lifting bar containing the oval cutout should be positioned over the top of the heat exchanger as shown.
- 4. Using proper rigging equipment, capable of supporting 1000 to 1200 lbs., lift the boiler and position it on the housekeeping pad.
- 5. After the boiler is properly set on the pad, detach the lifting bar and replace the shroud on the top of the unit.
- 6. Retain the lifting bar for possible reuse at the installation site.





VIEW B - LIFTING POSITION

Figure 2-2: Boiler Lifting Provisions

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

In multiple unit installations, it is important to plan the position of each unit in advance. Sufficient space for piping connections and future service/maintenance requirements must also be taken into consideration. All piping must include ample provisions for expansion.

If installing a Combination Control Panel (CCP) system, it is important to identify the Combination Mode Boilers in advance and place them in the proper physical location. Refer to Chapter 5 for information on Combination Mode Boilers.

2.5 SUPPLY AND RETURN PIPING

The Benchmark Boiler utilizes 3" 150# flanges for the water system supply and return piping connections. The physical location of the supply and return piping connections are on the rear of the unit as shown in Figure 2-3. Refer to Appendix F, Drawing AP-A-891 for additional dimensional data.

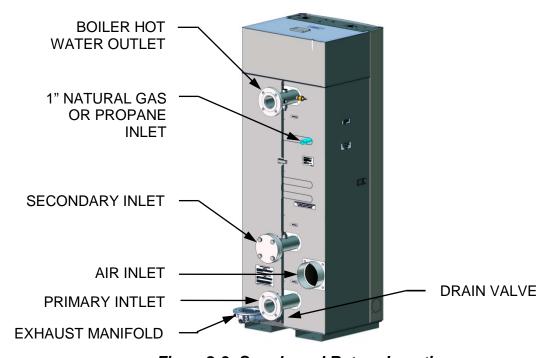


Figure 2-3: Supply and Return Locations

2.6 PRESSURE RELIEF VALVE INSTALLATION

An ASME rated Pressure Relief Valve is supplied with each Benchmark Boiler. The pressure rating for the relief valve must be specified on the sales order. Available pressure ratings range from 30 psi to 160 psi. The relief valve is installed on the hot water outlet of the boiler as shown in Figure 2-4. A suitable pipe joint compound should be used on the threaded connections. Any excess should be wiped off to avoid getting any joint compound into the valve body. The relief valve must be piped to within 12 inches of the floor to prevent injury in the event of a discharge. The relief piping must be full size, without reduction. No valves, restrictions, or other blockages are allowed in the discharge line. In multiple unit installations the discharge lines must <u>not</u> be manifolded together. Each must be individually run to a suitable discharge location.

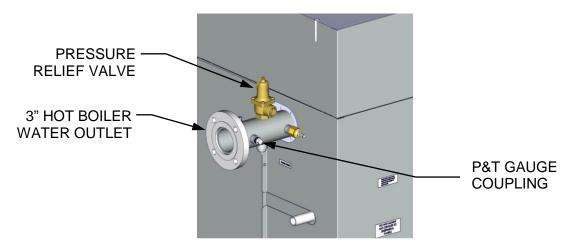


Figure 2-4: Pressure Relief Valve Location

2.7 CONDENSATE DRAIN & PIPING

The Benchmark Boiler is designed to condense water vapor from the flue products. Therefore, the installation must have provisions for suitable condensate drainage or collection.

The condensate drain port located on the exhaust manifold (Figure 2-5) must be connected to the condensate trap (part no. 24060) which is packed separately within the unit's shipping container. The condensate trap inlet and outlet connections contain tapped 3/4" NPT ports.

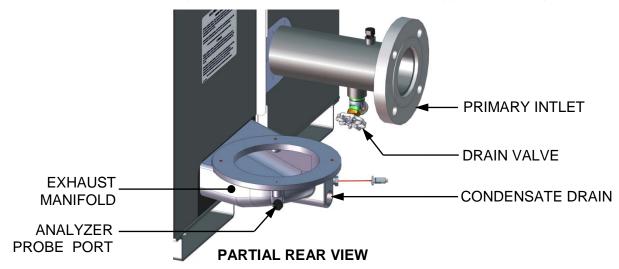


Figure 2-5: Condensate Drain Connection Location

A sample condensate trap installation is shown in Figure 2-6. However, the actual installation details for the trap will vary depending on the available clearances, housekeeping pad height/dimensions and other prevailing conditions at the site. The following general guidelines must be observed to ensure proper condensate drainage:

- The condensate trap inlet (Figure 2-6) must be level with, or lower than the exhaust manifold drain port.
- The base of the condensate trap must be supported to ensure that it is level (horizontal).
- The trap must be removable for routine maintenance. AERCO recommends that a union be utilized between the exhaust manifold condensate drain port and the trap inlet port.

While observing the above guidelines, install the condensate trap as follows:

Condensate Trap Installation

- 1. Connect the condensate trap inlet to the exhaust manifold drain connection using the appropriate piping components (nipples, reducers, elbows, etc.) for the boiler installation site.
- 2. At the condensate trap outlet, install a 3/4" NPT nipple.
- 3. Connect a length of 1" I.D polypropylene hose to the trap outlet and secure with a hose clamp.
- 4. Route the hose on the trap outlet to a nearby floor drain.

If a floor drain is not available, a condensate pump can be used to remove the condensate to an appropriate drain. The maximum condensate flow rate is 10 GPH. The condensate drain trap, associated fittings and drain line must be removable for routine maintenance.

△ CAUTION **△**

Use PVC, stainless steel, aluminum or polypropylene for condensate drain piping (Figure 2-6). DO NOT use carbon or copper components.

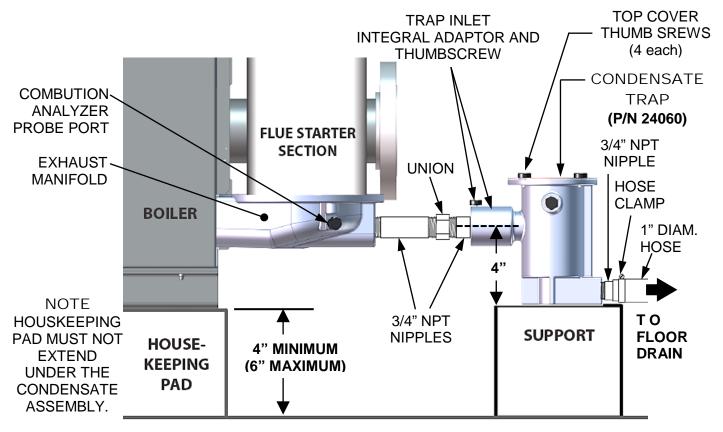


Figure 2-6: Sample Condensate Trap Installation

CHAPTER 2 – INSTALLATION

2.8 GAS SUPPLY PIPING

The AERCO Benchmark Gas Components and Supply Design Guide, GF-2030 must be consulted prior to designing or installing any gas supply piping.

Δ warning Δ

NEVER USE MATCHES, CANDLES, FLAMES OR OTHER SOURCES OF IGNITION TO CHECK FOR GAS LEAKS.

Δ CAUTION Δ

Many soaps used for gas pipe leak testing are corrosive to metals. Therefore, piping must be rinsed thoroughly with clean water after soap leak checks have been completed.

NOTE

All gas piping must be arranged so that it does not interfere with removal of any covers, inhibit service/maintenance, or restrict access between the unit and walls, or another unit.

Benchmark 750 and 1000 MBH units contain either a 1 inch NATURAL GAS or a 1 inch PROPANE gas inlet connection on the rear of the unit, as shown in Figure 2-3.

Prior to installation, all pipes should be de-burred and internally cleared of any scale, metal chips or other foreign particles. Do not install any flexible connectors or unapproved gas fittings. Piping must be supported from the floor, ceiling or walls only and must not be supported by the unit.

A suitable piping compound, approved for use with natural gas, should be used. Any excess must be wiped off to prevent clogging of components.

To avoid unit damage when pressure testing gas piping, isolate the unit from the gas supply piping. At no time should the gas pressure applied to the unit exceed 14" W.C. Leak test all external piping thoroughly using a soap and water solution or suitable equivalent. The gas piping used must meet all applicable codes.

2.8.1 Gas Supply Specifications

The gas supply input specifications to the unit are as follows:

The maximum static pressure to the unit must not exceed the following:

	Natural Gas	Propane
Benchmark 750	14" W.C.	14" W.C.
Benchmark 1000	14" W.C.	16" W.C.

Supply piping and pressure to the unit must be sufficient to provide the volume of gas while maintaining gas pressure listed below while operating at maximum capacity.

	Natural Gas	Propane
Benchmark 750	728 CFH, maintaining 4" W.C.	300 CFH, maintaining 7" W.C.
Benchmark 1000	976 CFH, maintaining 4" W.C.	400 CFH, maintaining 11" W.C.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

2.8.2 Manual Gas Shutoff Valve

A manual shut-off valve must be installed in the gas supply line upstream of the boiler as shown in Figure 2-7. Maximum allowable gas pressure to the boiler is 14" W.C.

2.8.3 External Gas Supply Regulator

An external gas pressure regulator is required on the gas inlet piping under most conditions (see sections 2.8.3.1 and 2.8.3.2, below). Regulators must conform to the following specifications:

- NATURAL GAS: The external natural gas regulator must be capable of regulating 49,000 – 1,020,000 BTU/HR while maintaining a minimum gas pressure of 4.0" W.C. to the unit.
- **PROPANE**: The external natural gas regulator must be capable of regulating **49,000 1,020,000** BTU/HR while maintaining a minimum gas pressure of **11.0**" **W.C.** to the unit.
- A lock-up style regulator MUST be used when gas supply pressure will exceed 14" W.C.

2.8.3.1 Massachusetts Installations Only

For Massachusetts installations, a mandatory external gas supply regulator must be positioned as shown in Figure 2-7. The gas supply regulator must be properly vented to outdoors. Consult the local gas utility for detailed requirements concerning venting of the supply gas regulator.

2.8.3.2 All Installations (Except Massachusetts)

For multi-unit installations (other than Massachusetts) that EXCEED 7" W.C. gas pressure, a separate external gas supply regulator, as shown in Figure 2-7, is highly recommended. No regulator is required for gas pressures below 7" W.C. of pressure. Consult the local gas utility for detailed requirements concerning venting of the supply gas regulator.

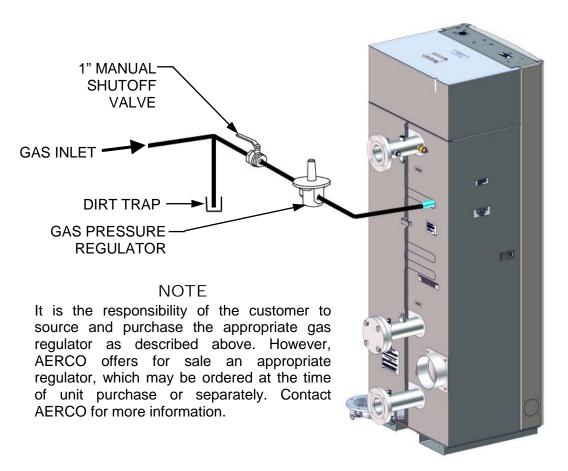


Figure 2-7: Manual Gas Shut-Off Valve and Gas Regulator Locations

2.9 AC ELECTRICAL POWER WIRING

The AERCO Benchmark Electrical Power Wiring Guide, GF-2060, must be consulted prior to connecting any AC power wiring to the unit. External AC power connections are made to the unit inside the Power Box. Remove the front panel to access the Power Box, which is mounted in the upper right corner of the unit as shown in Figure 2-8. Open the hinged cover of the Power Box to access the AC terminal block connections, and other internal components shown in Error! Reference source not found, 2-9.

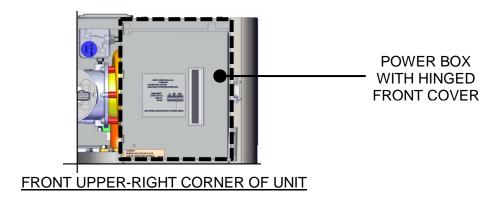


Figure 2-8: Power Box With Closed Cover

△ WARNING **△**

THE AC POWER OUTLETS SHOWN IN **ERROR! REFERENCE SOURCE NOT FOUND.** 2-9 ARE LIMITED TO 600 WATTS (5 AMP) SERVICE. <u>DO NOT</u> OVER-LOAD THESE OUTLETS. ALSO, THE FUSIBLE LINK SHOWN IN FIGURE 2-9 <u>DOES NOT</u> REMOVE POWER FROM THE TERMINAL BLOCKS OR AC OUTLETS.

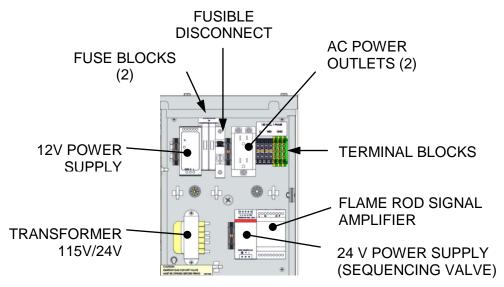


Figure 2-9: Power Box Internal Components

With the exception of the transformer shown in **Error! Reference source not found.** 2-9, all of the components in the Power Box are mounted on a DIN rail.

NOTE

All electrical conduit and hardware must be installed so that it does not interfere with the removal of any unit covers, inhibit service/maintenance, or prevent access between the unit and walls or another unit.

2.9.1 Electrical Power Requirements

The Benchmark Boiler accepts 120 VAC, single-phase, 60 Hz @ 20A. The Power Box contains terminal blocks as shown in Figure 2-10. In addition, a label showing the required AC power connections is provided on the front cover of the Power Box as shown in Figure 2-8.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

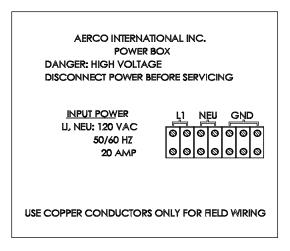


Figure 2-10: Power Box Cover Label

Each unit must be connected to a dedicated electrical circuit. NO OTHER DEVICES SHOULD BE ON THE SAME ELECTRICAL CIRCUIT AS THE BOILER.

A double-pole switch must be installed on the electrical supply line in an easily accessible location to quickly and safely disconnect electrical service. DO NOT attach the switch to sheet metal enclosures of the unit.

After placing the unit in service, the ignition safety shutoff device must be tested. If an external electrical power source is used, the installed boiler must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction. In the absence of such requirements, the installation shall conform to National Electrical Code (NEC), ANSI/NFPA 70 and/or the Canadian Electrical Code (CEC) Part I, CSA C22.1 Electrical Code.

For electrical power wiring diagrams, see the AERCO Benchmark Electrical Power Guide, (GF-2060).

2.10 FIELD CONTROL WIRING

Each unit is fully wired from the factory with an internal operating control system. No field control wiring is required for normal operation. However, the C-More Control system used with all Benchmark units does allow for some additional control and monitoring features. Wiring connections for these features are made on the Input/Output (I/O) board located behind the removable front panel assembly of the unit. The I/O board is located in the center-right portion on the front of the unit directly below the C-More Control Panel as shown in Figure 2-11.

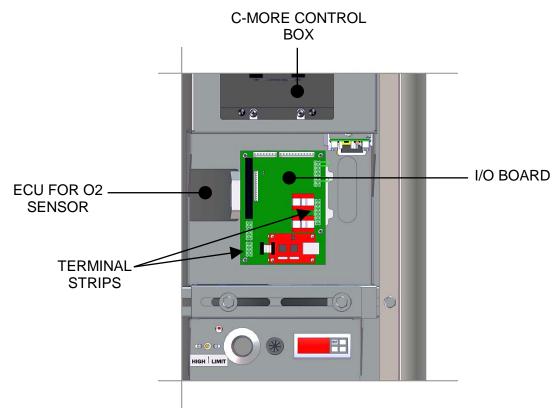


Figure2-11: Input/Output (I/O) Box Location

The I/O board terminal strip connections are shown in Figure 2-12. All field wiring is installed from the rear of the panel by routing the wires through one of the four bushings provided on the sides of the I/O board.

NOTE

Use Figure 2-12 to determine the functions of the I/O PCB connections. Do not use the silkscreened labels on the PCB itself, as these may not match.

\triangle CAUTION \triangle

DO NOT make any connections to the I/O Box terminals labeled "NOT USED". Attempting to do so may cause equipment damage.

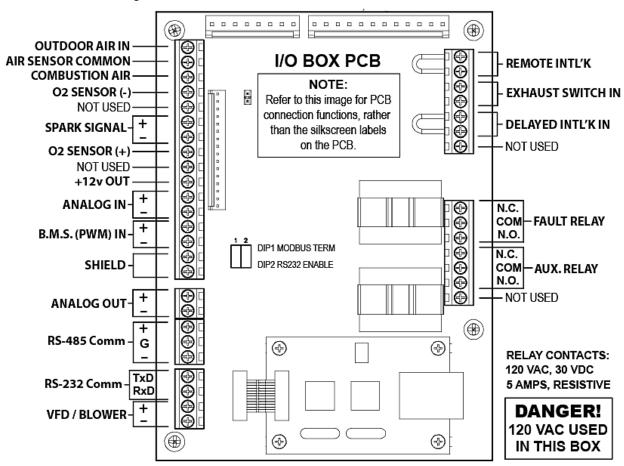


Figure 2-12: I/O Box Terminal Strips

2.10.1 OUTDOOR AIR IN Terminals

The OUTDOOR AIR IN terminal is used for connecting an outdoor temperature sensor (AERCO Part No. GM-123525), as required primarily for the Indoor/Outdoor reset mode of operation. It can also be used with another mode if it is desired to use the outdoor sensor enable/disable feature. This feature allows the boiler to be enabled or disabled based on the outdoor air temperature.

The factory default for the outdoor sensor is DISABLED. To enable the sensor and/or select an enable/disable outdoor temperature, see the Configuration menu in Chapter 3.

The outdoor sensor may be wired up to 200 feet from the boiler. It is connected to the OUTDOOR AIR IN and AIR SENSOR COMMON terminals in the I/O Box (see Figure 2-12). Wire the sensor using a twisted shielded pair wire from 18 to 22 AWG. There is no polarity to observe when terminating these wires. The shield is to be connected only to the terminals labeled SHIELD in the I/O Box. The sensor end of the shield must be left free and ungrounded.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

When mounting the sensor, it must be located on the North side of the building where an average outside air temperature is expected. The sensor must be shielded from direct sunlight as well as impingement by the elements. If a shield is used, it must allow for free air circulation.

2.10.2 COMBUSTION AIR Terminal

The COMBUSTION AIR terminal is used to monitor the combustion air temperature sensor. This input is always enabled and is a "to view only" input that can be seen in the operating menu. The sensor is an AERCO BALCO wire sensor P/N 12449. A resistance chart for this sensor is provided in APPENDIX C. This sensor is an active part of the combustion control system and must be operational for accurate air/fuel mixing control.

2.10.3 O₂ SENSOR Terminals

The O_2 SENSOR (+) and O_2 SENSOR (–) terminals are used to connect an external oxygen sensor to the I/O Box. The O_2 concentration is displayed in the operating menu of the C-More Control system after a 60 second warm-up period.

2.10.4 SPARK SIGNAL Terminals

The two SPARK SIGNAL terminals (+ & -) permit an external current sensor to be connected for ignition spark monitoring purposes. If no spark is present during the ignition sequence, the controller will shut down and display a fault message.

2.10.5 ANALOG IN Terminals

The two ANALOG IN terminals (+ and –) are used when an external signal is used to change the setpoint (Remote Setpoint Mode) of the boiler.

Either a 4 to 20 mA /1 to 5 VDC or a 0 to 20 mA/ 0 to 5 VDC signal may be used to vary the set-point or air/fuel valve position. The factory default setting is for 4 to 20 mA / 1 to 5 VDC, however this may be changed to 0 to 20 mA / 0 to 5 VDC using the Configuration Menu described in Chapter 3.

If voltage rather than current is selected as the drive signal, a DIP switch must be set on the PMC Board located inside the C-More Control Box. Contact the AERCO factory for information on setting DIP switches.

All supplied signals must be floating (ungrounded) signals. Connections between the source and the boiler's I/O Box (see Figure 2-12) must be made using twisted shielded pair of 18–22 AWG wire such as Belden 9841. Polarity must be maintained and the shield must be connected only at the source end and must be left floating (not connected) at the Boiler's I/O Box.

Whether using voltage or current for the drive signal, they are linearly mapped to a 40°F to 240°F setpoint or a 0% to 100% air/fuel valve position. No scaling for these signals is provided

2.10.6 B.M.S. (PWM) IN Terminals

These terminals are only used to connect TO the legacy AERCO Boiler Management System (BMS), which utilize a 12 millisecond, ON/OFF duty cycle and is Pulse Width Modulated (PWM) to control valve position. A 0% valve position = a 5% ON pulse and a 100% valve position = a 95% ON pulse. Note that these connections cannot be used with the AERCO Control System (ACS).

2.10.7 SHIELD Terminals

The two SHIELD terminals are used to terminate any shields used on sensor wires connected to the unit. Shields must only be connected to these terminals.

CHAPTER 2 – INSTALLATION

2.10.8 ANALOG OUT Terminals

The ANALOG OUT terminals (+ & -) output from 0 to 20 mA and may be used to monitor Setpoint, Outlet Temperature, Valve Position 4-20 mA, Valve Position 0-10v or be set to OFF. Default setting in the C-More controller is Valve Position 0-10v and settings behave as follows:

- When 0-10VDC is selected, the voltage output is used by the controller to modulate the combustion blower via the I/O Box terminals labeled VFD/Blower (Section 2.10.11).
- If On Board Boiler Sequencing Technology (BST) is enabled, the Analog Output terminals are used to drive the isolation valve, open and closed.
- When the 4-20mA is selected for the Analog Output, the 0-10VDC is disabled at the VFD/Blower terminals, and the selected output is available at the terminals labeled Analog Output +/-.

2.10.9 RS-485 Comm Terminals

The RS-485 communication terminals (+, GND, & -) are used when the boiler plant is being controlled by an Energy Management System (EMS) or AERCO Control System (ACS) using Modbus (RS-485) communication.

2.10.10 RS-232 Comm Terminals

The RS-232 communication terminals (TxD and RxD) permit a laptop computer or other suitable terminal to be connected to the boiler. The RS-232 communication feature permits viewing or changing of Control Panel menu options and also provides access to data logs showing fault and sensor log displays.

2.10.11 VFD/Blower (0-10 & AGND)

These terminals (0-10 & AGND) send an analog signal to control the blower speed. When any of the 4-20mA options is selected for the Analog Outputs (Section 2.10.8), the output from the VFD/Blower terminals is disabled.

2.10.12 Interlocks

The unit offers two interlock circuits for interfacing with Energy Management Systems and auxiliary equipment such as pumps or louvers or other accessories. These interlocks are called the Remote Interlock and Delayed Interlock (REMOTE INTL'K IN and DELAYED INTL'K IN in Figure 2-12). Both interlocks, described below, are factory wired in the closed position (using jumpers).

NOTE

Both the Delayed Interlock and Remote Interlock must be in the closed position for the unit to fire.

2.10.12.1 REMOTE INTL'K Terminals

The remote interlock circuit is provided to remotely start (enable) and stop (disable) the unit if desired. The is 24 VAC and comes factory pre-wired closed (jumped).

2.10.12.2 DELAYED INTL'K Terminals (OUT & IN)

The unit offers two interlock circuits for interfacing with Energy Management Systems and auxiliary equipment such as pumps or louvers or other accessories. These interlocks are called the Remote Interlock and Delayed Interlock ((REMOTE INTL'K IN and DELAYED INTL'K IN in Figure 2-12). Both interlocks, described below, are factory wired in the closed position (using jumpers).

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

NOTE

Both the Delayed Interlock and Remote Interlock must be in the closed position for the unit to fire.

2.10.12.2.1 Remote Interlock In (OUT & IN)

The remote interlock circuit is provided to remotely start (enable) and stop (disable) the unit if desired. The circuit is 24 VAC and comes factory pre-wired closed (jumped).

2.10.12.2.2 Delayed Interlock In (OUT & IN)

The Delayed Interlock terminals can be used in one of two ways:

- In conjunction with the optional external sequencing valve (see section 2.14 and Chapter 10 BST), a component of AERCO's on-board Boiler Sequencing Technology (BST) solution. By default a cable of the boiler's wiring harness is connected to these terminals. If BST is implemented, the other end of that cable is connected to the sequencing valve.
- If BST is NOT implemented, the second use is typically in conjunction with the AUXILIARY RELAY CONTACTS described in section 2.10.14. This interlock circuit is located in the purge section of the start string. It can be connected to the proving device (end switch, flow switch etc.) of an auxiliary piece of equipment started by the unit's auxiliary relay. If the delayed interlock is connected to a proving device that requires time to close (make), a time delay (AUX START ON DLY) that holds the start sequence of the unit long enough for a proving switch to make (close) can be programmed.

To use this option, you must disconnect the harness from the Delayed Interlock terminals and connect the proving device in its place.

Should the proving switch not prove within the programmed time frame, the unit will shut down. The AUX START ON DLY can be programmed from 0 to 120 seconds. This option is located in the Configuration Menu (Chapter 3).

2.10.13 FAULT RELAY (NC, COM, & NO) Terminals

The fault relay is a single pole double throw (SPDT) relay having a normally open and normally closed set of relay contacts that are rated for 5 amps at 120 VAC and 5 amps at 30 VDC. The relay energizes when any fault condition occurs and remains energized until the fault is cleared and the **CLEAR** button is depressed. The fault relay connections are shown in Figure 2-12.

2.10.14 AUX RELAY CONTACTS (NC, COM, & NO) Terminals

Each unit is equipped with a single pole double throw (SPDT) relay that is energized when there is a demand for heat and de-energized after the demand for heat is satisfied. The relay is provided for the control of auxiliary equipment, such as pumps and louvers, or can be used as a unit status indictor (firing or not firing). Its contacts are rated for 120 VAC @ 5 amps. Refer to Figure 2-12 to locate the AUX RELAY terminals for wiring connections.

2.11 FLUE GAS VENT INSTALLATION

AERCO Gas Fired Venting and Combustion Air Guide, GF-2050 must be consulted before any flue or combustion air venting is designed or installed. Suitable, U/L approved, positive pressure, watertight vent materials MUST be used for safety and UL certification. Because the unit is capable of discharging low temperature exhaust gases, the flue must be pitched back towards the unit a minimum of 1/4" per foot to avoid any condensate pooling and to allow for proper drainage.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

While there is a positive flue pressure during operation, the combined pressure drop of vent and combustion air systems must not exceed 140 equivalent feet or 1.9" W.C. Fittings as well as pipe lengths must be calculated as part of the equivalent length. For a natural draft installation the draft must not exceed - 0.25" W.C. These factors must be planned into the vent installation. If the maximum allowable equivalent lengths of piping are exceeded, the unit will not operate properly or reliably.

For Massachusetts installations, the following companies provide vent systems that conform to all applicable requirements for installations within the Commonwealth of Massachusetts. Contact information is as follows:

Selkirk Corporation - Heatfab Division

130 Industrial Blvd. Turners Falls, MA 01376 Phone: 1-800-772-0739

www.heat-fab.com

M. A. Peacard

1250 Massachusetts Ave. Boston MA 02125-1689 Phone: (617) 288-0629 www.mapeacard.com

Watertown Supply 33Grove St.

Watertown, MA 02472 Phone: (617) 924-2840

http://www.watertownsupply.com/

Glover Sheet Meatal, Inc.

44 Riverdale Ave. Newton, MA 02485 Phone: (617) 527-8178 www.gloversheetmetal.com

2.12 COMBUSTION AIR

The AERCO Benchmark Boiler Venting and Combustion Air Guide, GF-2050 MUST be consulted before any flue or inlet air venting is designed or installed. Air supply is a direct requirement of ANSI 223.1, NFPA-54, CSA B149.1 and local codes. These codes should be consulted before a permanent design is determined.

The combustion air must be free of chlorine, halogenated hydrocarbons or other chemicals that can become hazardous when used in gas-fired equipment. Common sources of these compounds are swimming pools, degreasing compounds, plastic processing, and refrigerants. Whenever the environment contains these types of chemicals, combustion air MUST be supplied from a clean area outdoors for the protection and longevity of the equipment and warranty validation.

The more common methods of combustion air supply are outlined in the following sections. For combustion air supply from ducting, consult the AERCO GF-2050, Gas Fired Venting and Combustion Air Guide.

2.12.1 Combustion From Outside the Building

Air supplied from outside the building must be provided through two permanent openings. For each unit these two openings must have a free area of not less than one square inch for each 4000 BTUs input of the equipment or 250 square inches of free area. The free area must take into account restrictions such as louvers and bird screens. For Canada installations, refer to the requirements specified in CSA B149.1-10, sections 8.4.1 and 8.4.3.

2.12.2 Combustion Air from Inside the Building

When combustion air is provided from within the building, it must be supplied through two permanent openings in an interior wall. Each opening must have a free area of not less than one square inch per 1000 BTUH of total input or 1000 square inches of free area. The free area must take into account any restrictions, such as louvers.

2.13 DUCTED COMBUSTION AIR

The AERCO Benchmark 750 & 1000 MBH Boilers are UL listed for 100%-ducted combustion. For ducted combustion air installations, the screen inlet air ductwork must then be attached directly to the unit's air inlet.

In a ducted combustion air application, the combustion air ducting pressure losses must be taken into account when calculating the total maximum allowable venting run. See the AERCO Benchmark Venting and Combustion Air Guide, GF-2050. When using the heater in a ducted combustion air configuration, each unit must have a minimum 6 inch diameter connection at the unit.

2.14 BENCHMARK PUMP RELAY OPTION

An optional Benchmark pump relay allows the user to turn a pump on/off and open/close a motorized valve as the boiler cycles on and off on demand. The Pump Delay Timer feature allows the user to keep the pump running and keep the motorized valve open for up to 30 minutes after the boiler has shut down and the demand is satisfied.

The Benchmark pump relay (SPDT) contact is rated for:

- 10 A Resistive @ 277 VAC/28 VDC
- 1/3 HP N/O @ 120/240 VAC
- 1/6 HP N/C @ 120/240 VAC
- 480 VA Pilot Duty @ 240-277 VAC

If pump/valve load exceeds the above contact ratings, use a separate contact relay.

See Figures 2-13 and 2-14 for wiring details.

To identify if the boiler is equipped with the BMK Pump Relay Option (part no. 69102), look for the label and relay as shown in Figure 2-15.

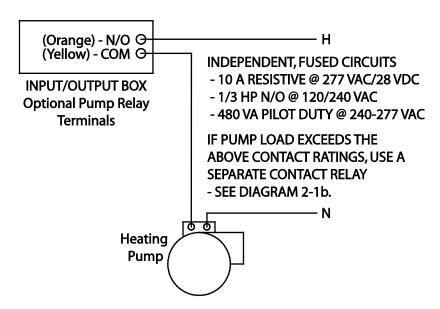


Figure 2-13: Schematic – System Pump Start using Boiler Pump Relay

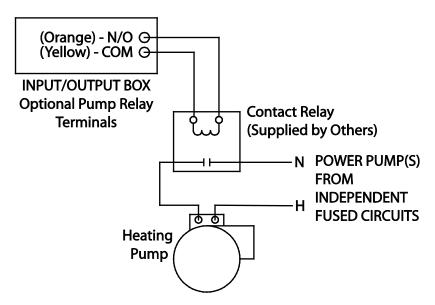


Figure 2-14: Schematic - System Pump Start using a Separate Contact Relay

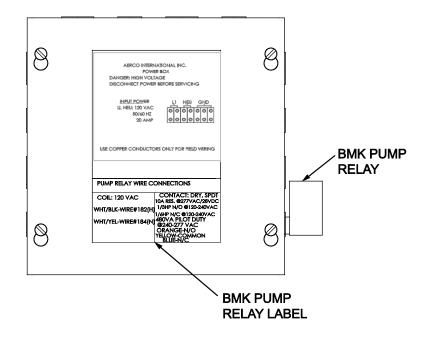


Figure 2-15: Identifying the Presence of BMK Pump Relay Option 69102

2.15 SEQUENCING ISOLATION VALVE INSTALLATION

All Benchmark units are shipped with a connection for an optional motorized external sequencing isolation valve (p/n 92084-TAB) included in the shipping container. This valve is an integral component of the AERCO's on-board Boiler Sequencing Technology (BST) solution. BST allows sites with multiple boilers to have one boiler, acting as a "master" to manage the other boilers at the site in such a way that the efficiency of the entire boiler array is maximized.

When operated with the BST system, the Master controls its own isolation valve and sends signals to the slave units to open or close their isolation valves. After the boiler load is satisfied,

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 2 – INSTALLATION

the isolation valve opens for a programmed interval (default = 1 minute) before closing. When the system load is satisfied, the BST system will open the isolation valves for all of the boilers.

The implementation of BST, and the installation and use of this valve is optional.

The boiler is pre-wired to accept the sequencing isolation valve. Installation consists of installing the sequencing isolation valve in the hot water outlet pipe, and then connecting it into the shell harness, as described below.

NOTE

When the Sequencing Isolation Valve is used, the AUX START ON DLY in the Configuration menu must be set to at least 120 seconds. The Sequencing Isolation Valve control is only available when BST is enabled. Refer to section 2.10.12.2 and Table 3-4 in section 3-6 and Chapter 10.

Installing Sequencing Isolation Valve

1. Install the sequencing isolation valve in the boiler's hot water outlet pipe.

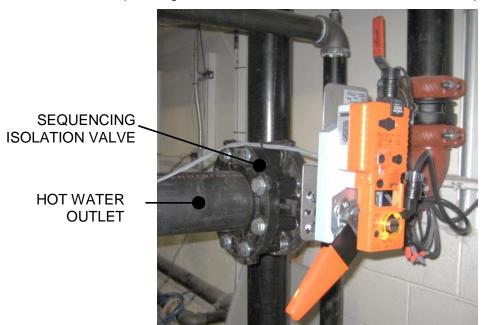


Figure 2-13: Sequencing Isolation Valve Installed

Installing Sequencing Isolation Valve - Continued

2. The boiler's shell harness has one unused cable. One end of this cable is connected to the DELAYED INTERLOCK IN terminals in the I/O board (see Figure 2-14) while the other end contains a Molex connector with a jumper wire inserted in it (this jumper wire allows units that do not have a sequencing isolation valve to operate normally). Find the free end of this cable inside the unit's enclosure.

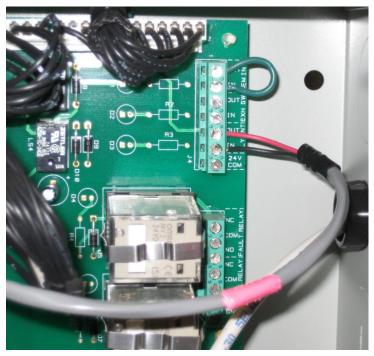


Figure 2-14: Sequencing Isolation Valve Installed

3. Remove the jumper wire from the Molex connector and then plug it into the sequencing isolation valve's connector.

CHAPTER 3. OPERATION

3.1 INTRODUCTION

The information in this Chapter provides a guide to the operation of the Benchmark Boiler using the Control Panel mounted on the front of the unit. It is imperative that the initial startup of this unit be performed by factory trained personnel. Operation prior to initial startup by factory trained personnel may void the equipment warranty. In addition, the following WARNINGS and CAUTIONS must be observed at all times.

MARNING M

ELECTRICAL VOLTAGES IN THIS SYSTEM INCLUDE 120 AND 24 VOLTS AC. IT MUST BE SERVICED ONLY BY FACTORY CERTIFIED SERVICE TECHNICIANS.

△ WARNING **△**

DO NOT ATTEMPT TO DRY FIRE THE UNIT. STARTING THE UNIT WITHOUT A FULL WATER LEVEL CAN SERIOUSLY DAMAGE THE UNIT AND MAY RESULT IN INJURY TO PERSONNEL OR PROPERTY DAMAGE. THIS SITUATION WILL VOID ANY WARRANTY.

△ CAUTION **△**

All of the installation procedures in Chapter 2 must be completed before attempting to start the unit.

3.2 CONTROL PANEL DESCRIPTION

All Benchmark Series Boilers utilize the C-More Control Panel shown in Figure 3-1. This panel contains all of the controls, indicators and displays necessary to operate, adjust and troubleshoot the boiler. These operating controls, indicators and displays are listed and described in Table 3-1. Additional information on these items is provided in the individual operating procedures and menu descriptions provided in this Chapter.

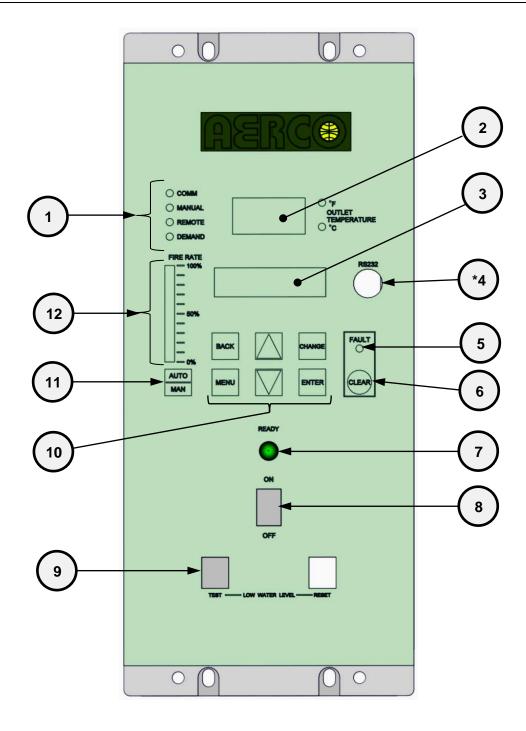


Figure 3-1: Control Panel Front View

*NOTE

If there is a requirement to use the RS232 port (Item 4) on the C-More controller front panel, contact AERCO to purchase the RS232 Adaptor Cable (P/N 124675), which is designed for this purpose. This cable features a DB9 connector for connection to older computers with serial ports or can be used with a Serial-to-USB adaptor for use in modern computer USB ports.

CHAPTER 3 – OPERATION

Table 3-1: Operating Controls, Indicators and Displays

1750	FEATURE S-1. Operating Controls, Indicators and Displays					
ITEM	FEATURE	FUNCTION				
	Four (4) Statu	LED Status Indicators s LEDs indicate the current operating status as follows:				
	COMM	Lights when RS-232 communication is occurring				
1	MANUAL	Lights when the valve position (fire rate) is being controlled using the front panel keypad. This mode of operation is for service technician use only.				
	REMOTE	Lights when the unit is being controlled by an external signal from an Energy Management System				
	DEMAND	Lights when there is a demand for heat.				
2	OUTLET TEMPERATURE Display	3–Digit, 7–Segment LED display continuously displays the outlet water temperature. The °F or °C LED next to the display lights to indicate whether the displayed temperature is in degrees Fahrenheit or degrees Celsius. The °F or °C blinks when operating in the Deadband Mode. On a BST Master, display flashes & shows header temperature.				
3	VFD Display	Vacuum Fluorescent Display (VFD) consists of 2 lines each capable of displaying up to 16 alphanumeric characters. The information displayed includes: • Startup Messages • Fault Messages • Operating Status Messages • Menu Selection • BST Messages				
4	RS-232 Port	Port permits a Laptop Computer or External Modem to be connected to the unit's Control Panel. AERCO offers for purchase the RS232 Adaptor Cable (P/N 124675), which is designed to work with this port. This cable features a DB9 connector for connection to older computers with serial ports or can be used with a Serial-to-USB adaptor for use in modern computer USB ports.				
5	FAULT Indicator	Red FAULT LED indicator lights when a boiler alarm condition occurs. An alarm message will appear in the VFD.				
6	CLEAR Key	Turns off the FAULT indicator and clears the alarm message if the alarm is no longer valid. Lockout type alarms will be latched and cannot be cleared by simply pressing this key. Troubleshooting may be required to clear these types of alarms.				
7	READY Indicator	Lights ON/OFF switch is set to ON and all Pro-Durgo conditions				
8	ON/OFF Switch	Enables and disables boiler operation.				
9	LOW WATER LEVEL TEST/RESET Switches	Allows operator to test operation of the water level monitor. Pressing TEST opens the water level probe circuit and simulates a Low Water Level alarm. Pressing RESET resets the water level monitor circuit. Pressing the CLEAR key (item 6) resets the display.				

CHAPTER 3 – OPERATION

Table 3-1: Operating Controls, Indicators and Displays – Continued

ITEM	FEATURE	FUNCTION				
	Six (6) keys pro	MENU Keypad ovide the following functions for the Control Panel Menus:				
	MENU	Steps through the main menu categories shown in Figure 3-2. The Menu categories wrap around in the order shown.				
	ВАСК	Allows you to go back to the previous menu level without changing any information. Continuously pressing this key will bring you back to the default status display in the VFD. Also, this key allows you to go back to the top of a main menu category.				
10	▲ (UP) Arrow	When in one of the main menu categories (Figure 3-2), pressing the ▲ arrow key will select the displayed menu category. If the CHANGE key was pressed and the menu item is flashing, pressing the ▲ arrow key will increment the selected setting.				
	When in one of the main menu categories (Figure 3-2), pressing this key will select the displayed menu category. If the CHANGE key was pressed and the menu item is flashing pressing the ▼ arrow key will decrement the selected setting.					
	CHANGE	Permits a setting to be changed (edited). When the CHANGE key is pressed, the displayed menu item will begin to flash. Pressing the ▲ or ▼ arrow key when the item is flashing will increment or decrement the displayed setting.				
	ENTER	Saves the modified menu settings in memory. The display will stop flashing.				
11	When in the Automatic (AUTO) mode, the MANU					
12	VALVE POSITION Bargraph	will be off and the front panel controls disabled. 20 segment red LED bargraph continuously shows the Air/Fuel Valve position in 5% increments from 0 to 100%				

CHAPTER 3 – OPERATION

3.3 CONTROL PANEL MENUS

The Control Panel incorporates an extensive menu structure which permits the operator to set up, and configure the unit. The menu structure consists of five major menu categories which are applicable to this manual. These categories are shown in Figure 3-2. Each of the menus shown, contain options which permit operating parameters to be viewed or changed. The menus are protected by a password levels to prevent unauthorized use.

Prior to entering the correct password, the options contained in the Operation, Setup, Configuration and Tuning Menu categories can be viewed. However, with the exception of Internal Setpoint Temperature (Configuration Menu), none of the viewable menu options can be changed.

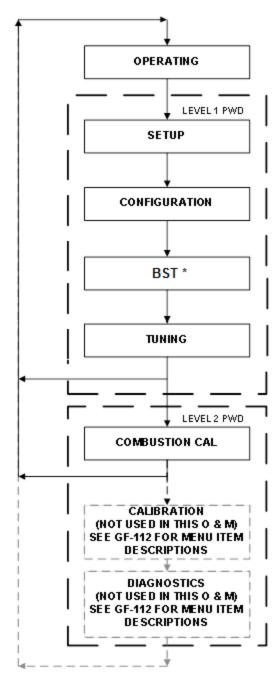
Once the valid level 1 password (159) is entered, the options listed in the Setup. Configuration and Tuning Menus can be viewed and changed, if desired. The Combustion Cal Menu is protected by the level 2 password (6817) which is used in Chapter 4 to perform combustion calibration prior to service use.

3.3.1 Menu Processing Procedure

Accessing and initiating each menu and option is accomplished using the Menu Keys shown in Figure 3-1. Therefore, it is imperative that you be thoroughly familiar with the following basic steps before attempting to perform specific menu procedures:

Menu Processing Procedure

- 1. The Control Panel will normally be in the Operating Menu and the VFD will display the current unit status. Pressing the ▲ or ▼ arrow key will display the other available data items in the Operating Menu.
- 2. Press the **MENU** key. The display will show the Setup Menu, which is the next menu category shown in Figure 3-2. This menu contains the Password option which must be entered if other menu options will be changed.
- 3. Continue pressing the **MENU** key until the desired menu is displayed.
- 4. With the desired menu displayed, press the ▲ or ▼ arrow key. The first option in the selected menu will be displayed.
- 5. Continue to press the ▲ or ▼ arrow key until the desired menu option is displayed. Pressing the ▲ arrow key will display the available menu options in the Top-Down sequence. Pressing the ▼ arrow key will display the options in the Bottom-Up sequence. The menu options will wrap-around after the first or last available option is reached.
- 6. To change the value or setting of a displayed menu option, press the **CHANGE** key. The displayed option will begin to flash. Press the ▲ or ▼ arrow key to scroll through the available menu option choices for the option to be changed. The menu option choices do not wrap around.
- 7. To select and store a changed menu item, press the **ENTER** key.



* Only if BST is enabled (see Chapter 10)

Figure 3-2: Menu Structure

NOTE

The following sections provide brief descriptions of the options contained in each menu. Refer to Appendix A for detailed descriptions of each menu option. Refer to Appendix B for listings and descriptions of displayed startup, status and error messages.

3.4 OPERATING MENU

The Operating Menu displays a number of key operating parameters for the unit as listed in Table 3-2. This menu is "Read-Only" and does not allow personnel to change or adjust any displayed items. Since this menu is "Read-Only", it can be viewed at any time without entering a password. Pressing the ▲ arrow key to display the menu items in the order listed (Top-Down). Pressing the ▼ arrow key will display the menu items in reverse order (Bottom-Up).

Table 3-2: Operating Menu

Menu Item Display	Available Cho	Default	
Wenu item Display	Minimum	Maximum	Delauit
Active Setpoint	40°F	240°F	
Inlet Temp	40°F	140°F	
Air Temp	-70°F	245°F	
Outdoor Temp*	-70°F	130°F	
Valve Position In	0%	100%	
Valve Position Out*	0%	100%	
Exhaust Temp	°F	°F	
Flame Strength	0%	100%	
Oxygen Level	0%	21%	
Run Cycles	0	999,999,999	
Run Hours	0	999,999,999	
Fault Log	0	19	0

*NOTE

The Outdoor Temp and Valve Position Out display items shown with an asterisk in Table 3-2 will not be displayed unless the Outdoor Sensor function has been enabled in the Configuration Menu (Table 3-4).

3.5 SETUP MENU

The Setup Menu (Table 3-3) permits the operator to enter the unit password (159) which is required to change the menu options. To prevent unauthorized use, the password will time-out after 1 hour. Therefore, the correct password must be reentered when required. In addition to permitting password entries, the Setup Menu is also used to enter date and time, units of temperature measurements and entries required for external communication and control of the unit via the RS-232 port. A view-only software version display is also provided to indicate the current Control Box software version.

CHAPTER 3 – OPERATION

Table 3-3: Setup Menu

Manu Itam Dianlau	Available Cho	Default	
Menu Item Display	Minimum	Maximum	Default
Password	0	9999	0
Language	Eng	jlish	English
Time	12:00 am	11:59 pm	
Date	01/01/00	12/31/99	
Unit of Temp	Fahrenheit	or Celsius	Fahrenheit
Comm Address	0	127	0
Baud Rate	2400, 4800, 9600, 19.2K		9600
Upload Timer	0		0
Unit Alpha	Α	Z	Α
Unit Serial #	0000	9999	0000
Unit Year	0	99	00
C-More Year	0	99	11
C-More Serial #	0	9999	0000
C-More Alpha	А	Z	Α
IP Address			
Software	Ver 0.00	Ver 9.99	

3.6 CONFIGURATION MENU

The Configuration Menu shown in Table 3-4 permits adjustment of the Internal Setpoint (Setpt) temperature regardless of whether the valid password has been entered. Setpt is required for operation in the Constant Setpoint mode. The remaining options in this menu require the valid password to be entered, prior to changing existing entries. This menu contains a number of other configuration settings which may or may not be displayed, depending on the current operating mode setting.

NOTE

The Configuration Menu settings shown in Table 3-4 are Factory-Set in accordance with the requirements specified for each individual order. Therefore, under normal operating conditions, no changes will be required.

Table 3-4: Configuration Menu

	Available Cho		
Menu Item Display	Minimum	Maximum	Default
Internal Setpt	Lo Temp Limit	Hi Temp Limit	130°F
Unit Type	KC Boiler, K BMK BIr Std, BI BMK BIr LN, B KC Water KC Water Innovat	BMK Bir LN	
Unit Size (Only the unit sizes available for the Unit Type will be displayed)	-	2000 MBH, 3000 MBH,	750 MBH or 1000 MBH
Fuel Type	Natural Ga	s, Propane	Natural Gas
Boiler Mode	Constant Remote Direct Combi Outdoo	Constant Setpoint	
Remote Signal (If Mode = Remote Setpoint, Direct Drive or Combination)	0 -20 m PWM Input (L	A/1 – 5V A/0 – 5V Legacy BMS), work	4 – 20 mA, 1-5V
Outdoor Sensor	Enabled o	r Disabled	Disabled
*Bldg Ref Temp (If Mode = Outdoor Reset)	40°F	230°F	70°F
*Reset Ratio (If Mode = Outdoor Reset)	0.1	1.2	
*System Start Tmp (If Outdoor Sensor = Enabled)	30°F	60°F	
Setpt Lo Limit	40°F	60°F	
Setpt Hi Limit	Setpt Lo Limit	210°F	140°F
Temp Hi Limit	40°F	210°F	160°F

*NOTE

The Bldg Ref Temp and Reset Ratio Menu Items are only displayed when the Outdoor Sensor is set to "Enabled".

Table 3-4: Configuration Menu - Continued

Manu Itam Dianlau	Available Cho	Default	
Menu Item Display	Minimum	Maximum	Default
Max Valve Position	40%	100%	100%
Pump Delay Timer	0 min.	30 min.	0 min.
Aux Start On Dly	0 sec.	120 sec.	0 sec.
Failsafe Mode	Shutdown or 0	Constant Setpt	Shutdown
Low Fire Timer	2 sec.	600 sec.	2 sec.
Setpt Limiting	Enabled o	r Disabled	Disabled
Setpt Limit Band	0°F	10°F	0
Network Timeout	5 Sec	999 Sec	30 Sec
HI DB Setpt EN	0%	100%	30%
Demand Offsert	0	25	0
Deadband High	0	25	0
Deadband Low	0	25	0
Spark Monitor	Enabled or Disabled		Disabled
Spark Current	Display		

\triangle CAUTION \triangle

DO NOT CHANGE the Analog Output Menu Item from its Default setting (Valve Position 0-10V).

3.7 TUNING MENU

The Tuning Menu items shown in Table 3-5 are Factory set for each individual unit. Do not change these menu entries unless specifically requested to do so by Factory-Trained personnel.

Table 3-5: Tuning Menu

Manu Itam Dianlau	Available Cho	Default	
Menu Item Display	Minimum	Maximum	Default
Prop Band	1°F	120°F	8°F
Integral Gain	0.00	2.00	1.6
Derivative Time	0.0 min	2.00 min	0.10 min
Warmup Prop Band	0°F	120°F	95°F
Warmup Int Gain	0	2.00	0.50
Warmup PID timer	0 sec. 240 sec.		20 sec.
Reset Defaults?	Yes, No, Are	No	

3.8 COMBUSTION CAL MENU

The Combustion Cal (Calibration) Menu is protected by the level 2 password (6817) which must be entered to view or change the menu items shown in Table 3-6. These menu items are used to vary the speed of the unit's blower motor based on air temperature and air density at prescribed Air/Fuel Valve positions (% open). This is accomplished by providing a DC drive voltage to the motor which adjusts the rotational speed of the blower to maximize combustion efficiency and ensure the unit conforms to the Nitrogen Oxide (NOx) and Carbon Monoxide (CO) emissions specified in Chapter 4. The valve positions (%) and default drive voltages are listed in Table 3-6.

Many Itam Dianley	Available Cho	Default	
Menu Item Display	Minimum	Maximum	Default
CAL Voltage 16%	1.70	2.20	1.80
CAL Voltage 30%	1.90	3.50	3.20
CAL Voltage 45%	2.60	4.40	3.70
CAL Voltage 60%	2.70	4.50	3.80
CAL Voltage 80%	3.60	4.40	4.60
CAL Voltage 100%	4.80	6.20	6.00
SET Valve Position	0%	100%	Variable
Blower Output	Monitor Blower Output Voltage		
Set Stdby Volt	0	4.00 V	0/2.00 V
Oxygen Level	0%	25%	Variable

Table 3-6: Combustion Cal Menu

3.9 BST (BOILER SEQUENCING TECHNOLOGY) MENU

The BST Menu must be Enabled in order to be displayed and accessed. The BST Enable item is located at the end of the Configuration Menu.

The Boiler Sequencing Technology (BST) Menu contains all of the items required to Configure, Operate and Monitor the functionality of the BST System. There are over 50 items in this menu, and selecting any particular item from the list, for inspection or modification, could be time consuming. As a result, the BST Menu has been segmented into FIVE logical groups based on functionality.

The five Item groups are:

- 1. BST Monitor Items
- 2. BST SETUP MENU*
- 3. * OPERATE MENU *
- 4. *TEMP CTRL MENU*
- 5. *BST COMM MENU*

These displayed item groups are displayed in UPPER CASE letters, and are bounded by an asterisk * in order to readily identify them within the item list.

CHAPTER 3 – OPERATION

The Items contained in group 1 (BST Monitor Items) are ALWAYS displayed within the menu, as these items are critical for proper system operation. Therefore, the BST Monitor Items Header itself is NOT displayed.

The Items contained in groups 2-5 are NOT DISPLAYED unless that particular item group has been enabled from the C-More keypad.

Table 3-7: BST Menu

Manu Itam Dianlay	Available Choices or Limits					Default		
Menu Item Display	Minimum			Ма	ximum	Default		
BST Mode	Off	BST	Slave		BST Master	Off		
BST Setpoint	BST Setpt Lo Lin	nit	BST Setpt Hi Limit		etpt Hi Limit	130°F		
Header Temp			۱A			Header Temp		
			·/ ·			(°F)		
BST Fire Rate	0			•	100%	Fire rate %		
BST Ave Fire Rate	0				100%	Avg Fire Rate %		
BST Outdoor Temp		١	NΑ			Outdoor Temp (°F)		
Units Available	0				8	Units Present		
Units Ignited	0				8	Units firing		
BST Valve State	0 (CLOSED)			1 (OPEN)	0		
1 Comm Errors 8	0				9	0		
1 BST Units 8	0 (see table)		0	(s	ee table)	0		
BST SETUP MENU	Disabled		Enabled		nabled	Disabled		
BST Setpoint Mode	Constant Setpoint		emote etpoint		Outdoor Reset	Constant Setpt		
Head Temp Source	Network		F	F۷	/D Temp	FFWD Temp		
Header Temp Addr	0				255	240		
Header Temp Point	0				255	14		
BST Outdoor Sens	Disabled			Е	nabled	Disabled		
Outdr Tmp Source	Outdoor Temp			Ν	etwork	Outdoor Temp		
Outdoor Tmp Addr	0				255	240		
Outdoor Tmp Pnt	0				255	215		
BST Remote Signal	4-20 mA/1-5 Vdc;	0-2	0 mA/0-5 Vdc;)	Network	Network		
BST Auto Mstr	No	•	NOTE! A Mod transmitter m		NOTE! A Modbu transmitter must		Yes adbus temperature nust be installed in with this feature.	No
BST Auto Timer	10 sec		120 sec		20 sec	30 sec		
Remote Intlk Use	Boiler Shutdowr	า	Syst	ten	n Shutdown	System Shutdown		

CHAPTER 3 – OPERATION

	Availal	5 ()			
Menu Item Display	Minimum	m Maximum			Default
One Boiler Mode	Off		Outlet emp	On-Avg Temp	Off
1 Bir Threshold	10		35		25
Setpoint Setback	Disable			Enable	Disable
Setback Setpoint	BST Setpt Lo Li	mit	BST	Γ Setpt HI Limit	130°F
Setback Start	12:00am			11:59pm	12.00am
Setback End	12:00am			11:59pm	12.00am
Rate Threshold	1°F			30°F	15°F
*BST OPERATE					<u> </u>
MENU*	Disabled			Enabled	Disabled
BST Next On VP	16%			100%	50%
BST Max Boilers	1			8	8
BST On Delay	30 sec			300 sec	60 sec
BST On Timeout	15 sec			300 sec	60 Sec
Valve Override	Off	Clo	osed	Open	Off
Valve Off Delay	0			15 min	1 min
BST Sequencing	Run Hours	Unit	Size	Select Lead	Run Hours
Select Lead Unit	0			127	0
Select Lag Unit	0			127	0
Lead/Lag Hours	25 hours			225 hours	72 hours
BST TEMP CTRL MENU	Disabled			Enabled	Disabled
BST Temp Hi Limit	40°F			210°F	210°F
BST Setpt Lo Limit	40°F		BST	Γ Setpt HI Limit	60°F
BST Setpt HI Limit	BST Setpt Lo Li	mit		220°F	195°F
BST Prop Band	1°F			120°F	100°F
BST Intgral Gain	0.00			2.00	0.50
BST Deriv Time	0.00 Min			2.00 Min	0.10 Min
BST Deadband Hi	0			25	1
BST Deadband Lo	0		25		1
Deadband En Time	0		120 Sec		30 Sec
BST FR Up Rate	1		120		20
BST Bldg Ref Tmp	40°F		230°F		70°F
BST Reset Ratio	0.1		9.9		1.2
System Start Tmp	30°F	30°F		120°F	60°F
BST COMM MENU	T COMM MENU* Disabled Enabled		Enabled	Disabled	

CHAPTER 3 – OPERATION

Menu Item Display	Available Cho	Default	
Wend item Display	Minimum	Maximum	Delault
Comm Address	0	127	0
BST Min Addr	1	128	1
BST Max Addr	1	128	8
SSD Address	0	250	247
SSD Poll Control	0	1000	0
Err Threshold	1	9	5
SSD Temp Format	Degrees	Points	Degrees
BST Upld Timer	0	9999 sec	0

3.10 START SEQUENCE

When the Control Box **ON/OFF** switch is set to the **ON** position, it checks all pre-purge safety switches to ensure they are closed. These switches include:

- Safety Shut-Off Valve (SSOV) Proof of Closure (POC) switch
- Low Water Level switch
- High Water Temperature switch
- High Gas Pressure switch
- Low Gas Pressure switch
- Blower Proof switch
- Blocked Inlet switch

If all of the above switches are closed, the **READY** light above the **ON/OFF** switch will light and the unit will be in the Standby mode.

When there is a demand for heat, the following events will occur:

NOTE

If any of the Pre-Purge safety device switches are open, the appropriate fault message will be displayed. Also, the appropriate messages will be displayed throughout the start sequence, if the required conditions are not observed.

- 1. The **DEMAND** LED status indicator will light.
- 2. The unit checks to ensure that the Proof of Closure (POC) switch in the downstream Safety Shut-Off Valve (SSOV) is closed. See Figure 3-3 for SSOV location.

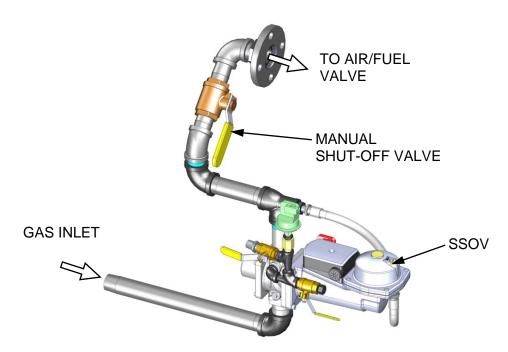


Figure 3-3: SSOV Location

- 3. With all required safety device switches closed, a purge cycle will be initiated and the following events will occur:
 - a) The Blower relay energizes and turns on the blower.
 - b) The Air/Fuel Valve rotates to the full-open purge position and closes purge position switch. The dial on the Air/Fuel Valve (Figure 3-4) will read 100 to indicate that it is full-open (100%).
 - c) The VALVE POSITION bargraph will show 100%.

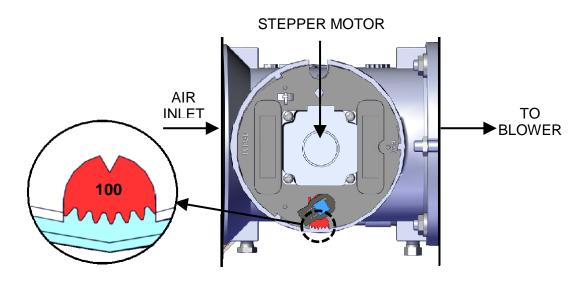


Figure 3-4: Air/Fuel Valve In Purge Position

CHAPTER 3 – OPERATION

4. Next, the blower proof switch on the Air/Fuel Valve (Figure 3-5) closes. The display will show *Purging* and indicate the elapsed time of the purge cycle in seconds.

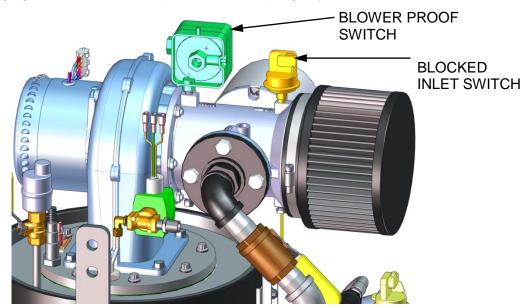


Figure 3-5: Blower Proof Switch

- 5. Upon completion of the purge cycle, the Control Box initiates an ignition cycle and the following events occur:
 - (a) The Air/Fuel Valve rotates to the low-fire ignition position and closes the ignition switch. The dial on the Air/Fuel Valve (Figure 3-6) will read between 25 and 35 to indicate that the valve is in the low-fire position.
 - (b) The igniter relay is activated and provides ignition spark. Current to the spark igniter is monitored for proper level. If no spark is present, the Controller will stop the ignition process at 3 seconds and shut down the boiler. Refer to Chapter 8 Troubleshooting for guidance if this occurs.
 - (c) The gas Safety Shut-Off Valve (SSOV) is energized (opened) allowing gas to flow into the Air/Fuel Valve.

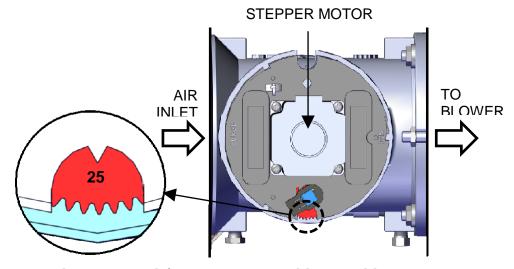


Figure 3-6: Air/Fuel Valve In Ignition Position

CHAPTER 3 – OPERATION

- 6. Up to 7 seconds will be allowed for ignition to be detected. The igniter relay will be turned off one second after flame is detected.
- 7. After 2 seconds of continuous flame, *Flame Proven* will be displayed and the flame strength will be indicated. After 5 seconds, the current date and time will be displayed in place of the flame strength.
- 8. With the unit firing properly, it will be controlled by the temperature controller circuitry. The boiler's **VALVE POSITION** will be continuously displayed on the front panel bargraph.

Once the demand for heat has been satisfied, the Control Box will turn off the SSOV gas valve. The blower relay will be deactivated and the Air/Fuel Valve will be closed. *Standby* will be displayed.

3.11 START/STOP LEVELS

The start and stop levels are the Air/Fuel Valve positions (% open) that start and stop the unit, based on load. These levels are Factory preset as follows:

Start Level: 22% Stop Level: 18%

Normally, these settings should not require adjustment.

Note that the energy input of the boiler is not linearly related to the Air/Fuel Valve position. Refer to Table 3-8 for the relationship between the energy input and Air/Fuel Valve position for a BMK 750 MBH or BMK 1000 MBH boiler running on natural gas.

Table 3-8: Relationship Between Air/Fuel Valve Position and Energy Input For 750 MBH & 1000 MBH Units Running On NATURAL GAS

Air/Fuel Valve		y Input J/Hr)	Boiler Energy Input (% of Full Capacity)		
Position (% Open)	750 MBH	1000 MBH	750 MBH	1000 MBH	
0%	0	0	0	0	
10%	0	0	0	0	
18% (Stop Level)	50,000	50,000	6.7%	5%	
20%	52,000	54,000	6.9%	5.4%	
30%	108,000	140,000	14%	14%	
40%	246,000	297,000	33%	30%	
50%	369,000	443,000	49%	44%	
60%	465,000	564,000	62%	56%	
70%	554,000	660,000	74%	66%	
80%	637,000	789,000	85%	79%	
90%	733,000	933,000	98%	93%	
100%	750,000	1,000,000	100%	100%	

CHAPTER 3 – OPERATION

Table 3-9: Relationship Between Air/Fuel Valve Position and Energy Input For 750 MBH & 1000 MBH Units Running On PROPANE

Air/Fuel Valve	Energy Input (BTU/Hr)		Boiler Energy Input (% of Full Capacity)	
Position (% Open)	750 MBH	1000 MBH	750 MBH	1000 MBH
0%	0	0	0	0
10%	0	0	0	0
18% (Stop Level)	50,000	50,000	6.7%	5.0%
20%	71,000	71,000	9.5%	7.1%
30%	128,000	181,000	17%	18%
40%	373,000	400,000	50%	40%
50%	508,000	562,000	68%	56%
60%	565,000	703,000	75%	70%
70%	621,000	791,000	83%	79%
80%	660,000	865,000	88%	87%
90%	723,000	963,000	96%	96%
100%	750,000	1,000,000	100%	100%

CHAPTER 4. INITIAL START-UP

4.1 INITIAL START-UP REQUIREMENTS

The requirements for the initial start-up of the Benchmark 750 or 1000 MBH boiler consists of the following:

- Complete installation (Chapter 2)
- Set proper controls and limits (Chapter 3)
- Perform combustion calibration (Chapter 4)
- Test safety devices (Chapter 6)

All applicable installation procedures in Chapter 2 must be fully completed prior to performing the initial start-up of the unit. The initial start-up must be successfully completed prior to putting the unit into service. Starting a unit without the proper piping, venting, or electrical systems can be dangerous and may void the product warranty. The following start-up instructions should be followed precisely in order to operate the unit safely and at a high thermal efficiency, with low flue gas emissions.

Initial unit start-up must be performed ONLY by AERCO factory trained start-up and service personnel. After performing the start-up procedures in this Chapter, it will be necessary to perform the Safety Device Testing procedures specified in Chapter 6 to complete all initial unit start-up requirements.

An AERCO Gas Fired Startup Sheet, included with each Benchmark, must be completed for each unit for warranty validation and a copy must be returned promptly to AERCO at:

AERCO International, Inc. 100 Oritani Drive Blauvelt, New York 10913 (FAX: 845-580-8090)

△ WARNING **△**

DO NOT ATTEMPT TO DRY FIRE THE UNIT. STARTING THE UNIT WITHOUT A FULL WATER LEVEL CAN SERIOUSLY DAMAGE THE UNIT AND MAY RESULT IN injury to PERSONNEL OR PROPERTY DAMAGE. THIS SITUATION WILL VOID any warranty.

NOTE

ALL APPLICABLE INSTALLATION PROCEDURES IN CHAPTER 2 MUST BE COMPLETED BEFORE ATTEMPTING TO START THE UNIT.

4.2 TOOLS AND INSTRUMENTATION FOR COMBUSTION CALIBRATION

To properly perform combustion calibration, the proper instruments and tools must be used and correctly attached to the unit. The following sections outline the necessary tools and instrumentation as well as their installation.

CHAPTER 4 - INITIAL START-UP

4.2.1 Required Tools & Instrumentation

The following tools and instrumentation are necessary to perform combustion calibration of the unit:

- Digital Combustion Analyzer: Oxygen accuracy to ± 0.4%; Carbon Monoxide (CO) and Nitrogen Oxide (NOx) resolution to 1PPM.
- 16 inch W.C. manometer or equivalent gauge and plastic tubing.
- 1/4 inch NPT-to-barbed fittings for use with gas supply manometer or gauge.
- Small and large flat blade screwdrivers.
- Tube of silicone adhesive

4.2.2 Installing Gas Supply Manometer

The gas supply manometer (or gauge) is used to monitor the gas pressure on the downstream side of the SSOV during the Combustion Calibration procedures described in section 4.3.

The gas supply manometer is installed at the upstream and/or downstream location shown in Figure 4-1.

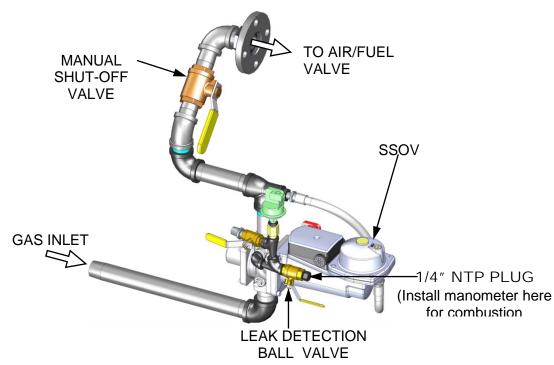


Figure 4-1: 1/4 Inch Gas Plug Location

Install the 16" W.C. manometer(s) as described in the following steps:

CHAPTER 4 – INITIAL START-UP

Installing Gas Supply Manometer

- 1. Turn off the main gas supply upstream of the unit.
- 2. Remove the top panel and front panel from the boiler to access the gas train components.
- 3. To monitor the gas pressure on the downstream side of the SSOV during Combustion Calibration (section 4.3), remove the 1/4" NPT plug from the leak detection ball valve on the downstream side of the SSOV as shown in Figure 4-1.
- 4. Install a NPT-to-barbed fitting into the tapped plug port.
- 5. Attach one end of the plastic tubing to the barbed fitting and the other end to the 16" W.C. manometer.

4.2.3 Accessing the Analyzer Probe Port

The unit contains a 1/4" NPT port on the side of the exhaust manifold as shown in Figure 4-2. Prepare the port for the combustion analyzer probe as follows:

Accessing Analyzer Probe Port

- 1. Refer to Figure 4-2 and remove the 1/4" NPT plug from the exhaust manifold.
- 2. If necessary, adjust the stop on the combustion analyzer probe so it will extend mid-way into the flue gas flow. DO NOT install the probe at this time.

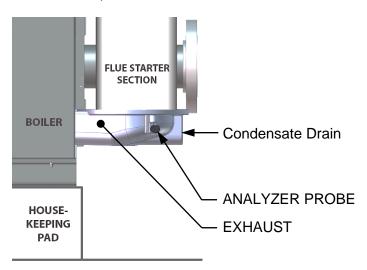


Figure 4-2: Analyzer Probe Port Location

CHAPTER 4 – INITIAL START-UP

4.3 NATURAL GAS COMBUSTION CALIBRATION

Complete the instructions below if the unit will run on Natural Gas rather than PROPANE gas.

NOTE

When installed and operated in accordance with the requirements specified in this section, this Benchmark boiler delivers low NOx emissions of <20 ppm at all firing rates. Alternatively, these boilers can be combustion calibrated to provide ultra-low NOx emissions of <9 ppm.

To combustion calibrate the boiler to produce *low NOx* emissions of <20 ppm, complete the instructions in this section. To combustion calibrate the boiler to produce *ultra-low NOx* emissions of <9 ppm, first complete the instructions in this section and then, *in addition*, complete the instructions in Appendix M.

The Benchmark 750/1000 boiler is combustion calibrated at the factory prior to shipping. However, recalibration is necessary as part of initial start-up due to changes in the local altitude, gas BTU content, gas supply piping and supply regulators. Combustion Calibration Test Data sheets are shipped with each unit. These sheets must be filled out and returned to AERCO for proper Warranty Validation.

It is important to perform the following procedure as outlined. This will keep readjustments to a minimum and provide optimum performance.

NATURAL GAS Combustion Calibration

- 1. Open the water supply and return valves to the unit and ensure that the system pumps are running.
- 2. Open the natural gas supply valve to the unit.
- 3. Set the control panel **ON/OFF** switch to the **OFF** position
- 4. Turn on external ac power to the unit. The display will show loss of power and the time and date.
- 5. Set the unit to the manual mode by pressing the **AUTO/MAN** key. A flashing manual valve position message will be displayed with the present position in %. Also, the **MANUAL** LED will light.
- 6. Adjust the air/fuel valve position to **0%** by pressing the ▼ arrow key.
- 7. Ensure that the leak detection ball valve downstream of the SSOV is open.
- 8. Set the **ON/OFF** switch to the **ON** position.
- 9. Change the valve position to **30**% using the ▲ arrow key. The unit should begin its start sequence and fire.
- 10. Next, verify that the gas pressure downstream of the SSOV is set to 2.0 ± 0.4 " W.C. If gas pressure adjustment is required, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure 4-3). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure of 2.0" W.C. ± 0.4 " W.C.

CHAPTER 4 - INITIAL START-UP



Figure 4-3: Gas Pressure Adjustment Screw Location

- 11. Using the ▲ arrow key, increase the valve open position to 100%. Verify that the gas pressure on the downstream side of the SSOV settles within the range of 2.0" W.C. ± 0.4" W.C. Readjust the gas pressure if necessary.
- 12. With the valve position at 100%, insert the combustion analyzer probe into the flue probe opening and allow enough time for the combustion analyzer reading to stabilize.
- 13. Compare the oxygen readings on the combustion analyzer to the on-board O_2 sensor value displayed in the Operating Menu of the C-More Control Panel. If the values differ by more than $\pm 1.5\%$ and your combustion analyzer is correctly calibrated, the on-board O_2 sensor may be defective and need to be replaced.
- 14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a "NOx-limited" area and/or do not have a NOx measurement in your analyzer, set the oxygen (O_2) at 5.5% \pm 0.5%.

Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
100%	5% - 6%	<20 ppm	<100 ppm

- 15. If the oxygen level is not within the required tolerance, the gas pressure on the downstream side of the SSOV must be adjusted using the gas pressure adjustment screw on the SSOV (Figure 4-3). Slowly rotate the gas pressure adjustment (approximately 1/4-turn increments). Allow the combustion analyzer to stabilize following each adjustment. Clockwise rotation reduces the oxygen level, while counterclockwise rotation increases the oxygen level.
- 16. Once the oxygen level is within the specified range at 100%, record the O₂, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.
- 17. Lower the valve position to 80% using the ▼arrow key.

CHAPTER 4 – INITIAL START-UP

NATURAL GAS Combustion Calibration - Continued

NOTE

The remaining combustion calibration steps are performed using the Combustion Cal Menu included in the C-More Control System. The combustion calibration control functions will be used to adjust the oxygen level (%) at valve positions of 80%, 60%, 45%, 30% and 18% as described in the following steps. These steps assume that the inlet air temperature is within the range of 50°F to 100°F. If NOx readings exceed the target values shown, increase the O_2 level up to 1% higher than the listed calibration range. Record the increased O_2 value on the Combustion Calibration sheet.

- 18. Press the **MENU** key on the front panel of the C-More and access the *Setup* menu. Enter password **6817** and then press the **ENTER** key.
- 19. Press the **MENU** key until **Combustion Cal Menu** appears on the display.
- 20. Press the ▲ arrow key until **SET Valve Position** appears on the display.
- 21. Press the CHANGE key. SET Valve Position will begin to flash.
- 22. Press the ▲ arrow key until **SET Valve Position** reads **80%**. Press the **ENTER** key.
- 23. Next, press the down (▼) arrow key until *CAL Voltage 80%* is displayed.
- 24. Press the CHANGE key and observe that CAL Voltage 80% is flashing.
- 25. The oxygen level at the 80% valve position should be as shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the following values:

Natural Gas Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
80%	5% - 6%	<20 ppm	<100 ppm

- 26. If the oxygen level is not within the specified range, adjust the level using the ▲ and ▼ arrow keys. This will adjust the output voltage to the blower motor as indicated on the display. Pressing the ▲ arrow key increases the oxygen level and pressing the down ▼ arrow key decreases the oxygen level.
- 27. Once the oxygen level is within the specified range at 80%, press the **ENTER** key to store the selected blower output voltage for the 80% valve position. Record all readings on the Combustion Calibration Sheets provided.
- 28. Repeat steps 20 through 27 for valve positions of 60%, 45%, 30% and 18%* (see *NOTE below). The oxygen (O₂), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

CHAPTER 4 - INITIAL START-UP

NATURAL GAS Combustion Calibration - Continued

*NOTE

Set the Valve Position at 18% but make adjustments to the Combustion Calibration value designated as 16%.

NOTF

If NOx readings exceed the target values shown (<20 ppm), increase the O_2 level up to 1% higher than the listed calibration range shown in the table. Record the increased O_2 value on the Combustion Calibration sheet.

Natural Gas Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
60%	5% - 6%	<20 ppm	<100 ppm
45%	5% - 6%	<20 ppm	<100 ppm
30%	5% - 6%	<20 ppm	<100 ppm
18%	5% - 6%	<20 ppm	<100 ppm

- 29. If the oxygen level at the 18% valve position is too high and the Blower voltage is at the minimum value, you can adjust the idle screw (TAC valve) which is recessed in the top of the Air/Fuel Valve (see Appendix G). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O₂ to the specified level. Recalibration MUST be performed again from 60% down to 18% after making a change to the idle screw (TAC valve).
- 30. This completes the NATURAL GAS combustion calibration procedures.

4.4 PROPANE COMBUSTION CALIBRATION

Complete the instructions below if the unit will run on PROPANE gas rather than Natural Gas.

NOTE

When installed and operated in accordance with the requirements specified in this section, this Benchmark boiler delivers low NOx emissions of <30 ppm at all firing rates. Unlike units running on Natural Gas, there is no ultra-low NOx emissions option.

The Benchmark 750/1000 boiler is combustion calibrated at the factory prior to shipping. However, recalibration is necessary as part of initial start-up due to changes in the local altitude, gas BTU content, gas supply piping and supply regulators. Combustion Calibration Test Data sheets are shipped with each unit. These sheets must be filled out and returned to AERCO for proper Warranty Validation.

It is important to perform the following procedure as outlined. This will keep readjustments to a minimum and provide optimum performance.

CHAPTER 4 – INITIAL START-UP

PROPANE Combustion Calibration

- 1. Open the water supply and return valves to the unit and ensure that the system pumps are running.
- 2. Open the natural gas supply valve to the unit.
- 3. Set the control panel **ON/OFF** switch to the **OFF** position
- 4. Turn on external ac power to the unit. The display will show loss of power and the time and date.
- 5. Set the unit to the manual mode by pressing the **AUTO/MAN** key. A flashing manual valve position message will be displayed with the present position in %. Also, the **MANUAL** LED will light.
- 6. Adjust the air/fuel valve position to **0**% by pressing the ▼ arrow key.
- 7. Ensure that the leak detection ball valve downstream of the SSOV is open.
- 8. Set the **ON/OFF** switch to the **ON** position.
- 9. Change the valve position to **30**% using the ▲ arrow key. The unit should begin its start sequence and fire.
- 10. Next, verify that the gas pressure downstream of the SSOV is set to:
 - Benchmark 750 units: 3.9" ± 0.2" W.C.
 - Benchmark 1000 units: 7.4" ± 0.2" W.C.

If gas pressure adjustment is required, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure 4-3, above). Make gas pressure adjustments using a flat-tip screwdriver to obtain the gas pressure listed above.

- 11. Using the ▲ arrow key, increase the valve open position to 100%. Verify that the gas pressure on the downstream side of the SSOV settles within the range listed in step 10 (3.9" ± 0.2"" or 7.4" ± 0.2"). Readjust the gas pressure if necessary.
- 12. With the valve position at 100%, insert the combustion analyzer probe into the flue probe opening and allow enough time for the combustion analyzer reading to stabilize.
- 13. Compare the oxygen readings on the combustion analyzer to the on-board O₂ sensor value displayed in the Operating Menu of the C-More Control Panel. If the values differ by more than ±1.5% and your combustion analyzer is correctly calibrated, the on-board O₂ sensor may be defective and need to be replaced.
- 14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a "NOx-limited" area and/or do not have a NOx measurement in your analyzer, set the oxygen (O_2) at 5.5% \pm 0.5%.

Propane Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
100%	5% - 6%	<30 ppm	<100 ppm

CHAPTER 4 - INITIAL START-UP

PROPANE Combustion Calibration - Continued

- 15. If the oxygen level is not within the required tolerance, the gas pressure on the downstream side of the SSOV must be adjusted using the gas pressure adjustment screw on the SSOV (Figure 4-3, above). Slowly rotate the gas pressure adjustment (approximately 1/4-turn increments). Allow the combustion analyzer to stabilize following each adjustment. Clockwise rotation reduces the oxygen level, while counterclockwise rotation increases the oxygen level.
- 16. Once the oxygen level is within the specified range at 100%, record the O₂, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.
- 17. Lower the valve position to **80%** using the **▼**arrow key.

NOTE

The remaining combustion calibration steps are performed using the Combustion Cal Menu included in the C-More Control System. The combustion calibration control functions will be used to adjust the oxygen level (%) at valve positions of 80%, 60%, 45%, 30% and 18% as described in the following steps. These steps assume that the inlet air temperature is within the range of 50°F to 100°F. If NOx readings exceed the target values shown, increase the O_2 level up to 1% higher than the listed calibration range. Record the increased O_2 value on the Combustion Calibration sheet.

- 18. Press the **MENU** key on the front panel of the C-More and access the *Setup* menu. Enter password **6817** and then press the **ENTER** key.
- 19. Press the **MENU** key until **Combustion Cal Menu** appears on the display.
- 20. Press the ▲ arrow key until **SET Valve Position** appears on the display.
- 21. Press the CHANGE key. SET Valve Position will begin to flash.
- 22. Press the ▲ arrow key until **SET Valve Position** reads **80%**. Press the **ENTER** key.
- 23. Next, press the down (▼) arrow key until *CAL Voltage 80%* is displayed.
- 24. Press the CHANGE key and observe that CAL Voltage 80% is flashing.
- 25. The oxygen level at the 80% valve position should be as shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the following values:

Propane Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
80%	5% - 6%	<30 ppm	<100 ppm

26. If the oxygen level is not within the specified range, adjust the level using the ▲ and ▼ arrow keys. This will adjust the output voltage to the blower motor as indicated on the display. Pressing the ▲ arrow key increases the oxygen level and pressing the down ▼ arrow key decreases the oxygen level.

CHAPTER 4 – INITIAL START-UP

PROPANE Combustion Calibration - Continued

- 27. Once the oxygen level is within the specified range at 80%, press the **ENTER** key to store the selected blower output voltage for the 80% valve position. Record all readings on the Combustion Calibration Sheets provided.
- 28. Repeat steps 20 through 27 for valve positions of 60%, 45%, 30% and 18%* (see *NOTE below). The oxygen (O₂), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

*NOTF

Set the Valve Position at 18% but make adjustments to the Combustion Calibration value designated as 16%.

NOTE

If NOx readings exceed the target values shown (<30 ppm), increase the O_2 level up to 1% higher than the listed calibration range shown in the table. Record the increased O_2 value on the Combustion Calibration sheet.

Propane Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
60%	5% - 6%	<30 ppm	<100 ppm
45%	5% - 6%	<30 ppm	<100 ppm
30%	5.8% - 6.8%	<30 ppm	<100 ppm
18%	5% - 6%	<30 ppm	<100 ppm

- 29. If the oxygen level at the 18% valve position is too high and the Blower voltage is at the minimum value, you can adjust the idle screw (TAC valve) which is recessed in the top of the Air/Fuel Valve (see Appendix G). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O₂ to the specified level. Recalibration MUST be performed again from 60% down to 18% after making a change to the idle screw (TAC valve).
- 30. This completes the PROPANE combustion calibration procedures.

4.5 REASSEMBLY AFTER COMBUSTION CALIBRATION

Once the combustion calibration adjustments are properly set, the unit can be reassembled for service operation.

Reassembly After Combustion Calibration

- 1. Set the **ON/OFF** switch in the **OFF** position.
- 2. Disconnect AC power from the unit.
- 3. Shut off the gas supply to the unit.
- 4. Remove the manometer and barbed fittings and reinstall the NPT plug using a suitable pipe thread compound.

CHAPTER 4 - INITIAL START-UP

Reassembly After Combustion Calibration - Continued

- 5. Remove the combustion analyzer probe from the 1/4" vent hole in the exhaust manifold. Replace the 1/8" NPT plug in the manifold.
- 6. Replace all previously removed sheet metal enclosures on the unit.

4.6 OVER-TEMPERATURE LIMIT SWITCHES

The unit contains three (3) types of over-temperature limit switches. These switches consist of a Manual Reset Switch, a Rotary Dial Adjustable Switch and a Digital Alarm Switch. These switches are mounted on a plate as shown in Figure 4-4. The switches can be accessed by removing the unit front panel from the unit.

The manual reset switch is not adjustable and is permanently fixed at 210°F. This switch will shut down and lock out the boiler if the water temperature exceeds 210°F. Following an overtemperature condition, it must be manually reset by pressing the manual reset button shown in Figurer 4-4 before the boiler can be restarted.

The rotary dial temperature limit switch is manually adjustable from $32^{\circ}F$ - $212^{\circ}F$ ($0^{\circ}C - 100^{\circ}C$). This switch allows the boiler to restart, once the temperature drops below the selected temperature setting on the dial. Set the dial on this over-temperature switch to the desired setting.

The digital alarm switch shown in Figures 4-5 and 4-6 is preset at the factory to 210°F and should not be changed. If an over-temperature condition is detected, this switch automatically shuts down the boiler and sounds an audible alarm. If desired, the over-temperature alarm switch settings can be checked or adjusted using the procedure in section 4.5.1.

OMM-0082_0J GF-130

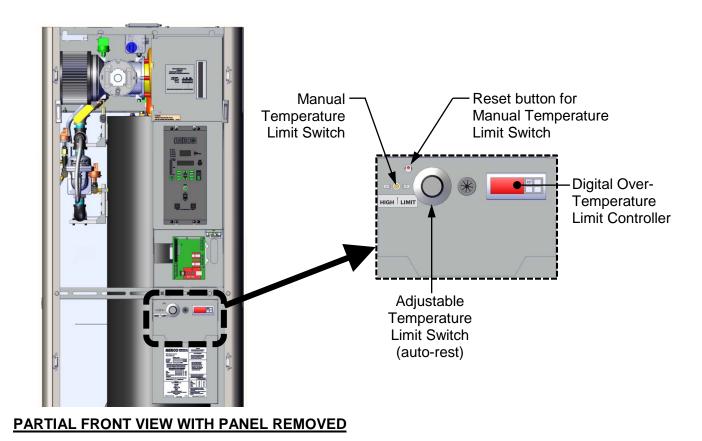


Figure 4-4: Over Temperature Limit Switch Locations

4.6.1 Digital Alarm Switch Checks and Adjustments

The digital alarm switch settings can be checked or adjusted using the controls and display on the front panel of the switch illustrated and described in Figure 4-5.

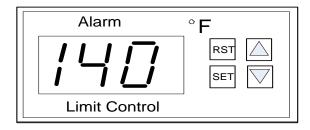


Figure 4-5: Digital Alarm Switch Front Panel

Table 4-1: Digital Over-Temperature Limit Controller Features

CONTROL OR DISPLAY	MEANING	FUNCTION	
LED Display	TEMP status	Displays current water temperature or setpoint.	
RST	RESET Button	Resets the unit after an alarm condition.	
\triangle	UP Button	Increases the displayed temperature.	
\bigvee	DOWN Button	Decreases the displayed temperature.	
SET	SET Button	Used to access and store parameters in the unit.	

Perform the steps in the following procedure to check or adjust the digital alarm switch settings:

Switch Check or Adjustment

- 1. Set the **ON/OFF** to the ON position.
- 2. Press the **SET** button on the Digital Alarm Switch. **SP** will appear in the display.
- 3. Press the **SET** button again. The current over-temperature limit value stored in memory will be displayed. (default = 210°F).
- 4. If the display does not show the required over-temperature alarm setting, press the ▲ or ▼ arrow button to change the display to the desired temperature setting.
- 5. Once the desired over-temperature alarm setting (210°F) is displayed, press the **SET** button to store the setting in memory.
- 6. To calibrate the offset (P1), press and hold the **SET** button for 8 seconds on the Digital Alarm Switch. Access code value 0 should appear in the display. The switch comes from the factory with the code set at 0. AERCO recommends that you do not change this code.
- 7. Press the **SET** button again to enter the code. The first parameter label (*SP*) will appear in the display.
- 8. Using the ▲ and ▼ arrow keys, select parameter P1.
- 9. Press **SET** to view the value stored in memory.
- 10. If the desired value is not displayed, modify the setting using the ▲ and ▼ arrow keys. The value can be changed from -10° to +10° offset. Press **SET** to enter the value and exit to the text parameter.
- 11. To exit the programming mode, press the **SET** and **▼** buttons simultaneously, or simply wait one minute and the display will automatically exit the programming mode.
- 12. Once the programming mode has been exited, the display will show the current outlet water temperature of the boiler.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 4 – INITIAL START-UP (This Page Is Intentionally Blank)

CHAPTER 5. MODE OF OPERATION

5.1 INTRODUCTION

The boiler is capable of being operated in any one of six different modes. The following sections in this Chapter provide descriptions of each of these operating modes. Each boiler is shipped from the factory tested and configured for the ordered mode of operation. All temperature related parameters are at their factory default values which work well in most applications. However, it may be necessary to change certain parameters to customize the unit to the system environment. A complete listing and descriptions of the temperature related parameters are included in Appendix A. Factory defaults are listed in Appendix E. After reading this chapter, parameters can be customized to suit the needs of the specific application.

5.2 INDOOR/OUTDOOR RESET MODE

This mode of operation is based on outside air temperatures. As the outside air temperature decreases, the supply header temperature will increase and vice versa. For this mode, it is necessary to install an outside air sensor as well as select a building reference temperature and a reset ratio.

5.2.1 Reset Ratio

Reset ratio is an adjustable number from 0.1 to 9.9. Once adjusted, the supply header temperature will increase by that number for each degree that the outside air temperature decreases. For instance, if a reset ratio of 1.6 is used, for each degree that outside air temperature decreases the supply header temperature will increase by 1.6 degrees.

5.2.2 Building Reference Temperature

This is a temperature from 40°F to 230°F. Once selected, it is the temperature that the system references to begin increasing its temperature. For instance, if a reset ratio of 1.6 is used, and we select a building reference temperature of 70°F, then at an outside temperature of 69°F, the supply header temperature will increase by 1.6° to 71.6°F.

5.2.3 Outdoor Air Temperature Sensor Installation

The outdoor air temperature sensor must be mounted on the North side of the building in an area where the average outside air temperature is expected. The sensor must be shielded from the sun's direct rays, as well as direct impingement by the elements. If a cover or shield is used, it must allow free air circulation. The sensor may be mounted up to two hundred feet from the unit. Sensor connections are made at the Input/Output (I/O) Box on the front of the boiler. Connections are made at the terminals labeled OUTDOOR AIR IN and AIR SENSOR COM inside the I/O Box. Use shielded 18 to 22 AWG wire for connections. A wiring diagram is provided on the cover of the I/O Box. Refer to Chapter 2, section 2.9.1 for additional wiring information.

CHAPTER 5 - MODE OF OPERATION

5.2.4 Indoor/Outdoor Startup

Startup in the Indoor/Outdoor Reset Mode is accomplished as follows:

NOTE

A design engineer typically provides design outdoor air temperature and supply header temperature data

Indoor/Outdoor Startup

- 1. Refer to the Indoor/Outdoor reset ratio charts in Appendix D.
- 2. Choose the chart corresponding to the desired Building Reference Temperature.
- 3. Go down the left column of the chart to the coldest design outdoor air temperature expected in your area.
- 4. Once the design outdoor air temperature is chosen, go across the chart to the desired supply header temperature for the design temperature chosen in step 3.
- 5. Next, go up that column to the Reset Ratio row to find the corresponding reset ratio.
- 6. Access the Configuration Menu and scroll through it until the display shows Bldg Ref Temp. (Building Reference Temperature). If necessary, refer to section 3.3 for detailed instructions on menu changing.
- 7. Press the **CHANGE** key. The display will begin to flash.
- 8. Use the ▲ and ▼ arrow keys to select the desired Building Reference Temperature.
- 9. Press **ENTER** to save any changes.
- 10. Next, scroll through the Configuration Menu until the display shows Reset Ratio.
- 11. Press the **CHANGE** key. The display will begin to flash.
- 12. Use the ▲ and ▼ arrow keys to select the Reset Ratio determined in step 5.
- 13. Press **ENTER** to save the change.

5.3 CONSTANT SETPOINT MODE

The Constant Setpoint mode is used when a fixed header temperature is desired. Common uses of this mode of operation include water source heat pump loops, and indirect heat exchangers for potable hot water systems or processes.

No external sensors are required to operate in this mode. While it is necessary to set the desired setpoint temperature, it is not necessary to change any other temperature-related functions. The unit is factory preset with settings that work well in most applications. Prior to changing any temperature-related parameters, other than the setpoint, it is suggested that an AERCO representative be contacted. For descriptions of temperature-related functions and their factory defaults, see Appendices A and E.

5.3.1 Setting the Setpoint

The setpoint temperature of the unit is adjustable from 40°F to 240°F. To set the unit for operation in the Constant Setpoint Mode, the following menu settings must be made in the Configuration Menu:

Table 5-1: Constant Setpoint Mode Settings

Menu Option	Setting
Boiler Mode	Constant Setpoint
Internal Setpt	Select desired setpoint using ▲ and ▼ arrow keys (40°F to 240°F)

Refer to section 3.3 for detailed instructions on changing menu options.

5.4 REMOTE SETPOINT MODES

The unit's setpoint can be remotely controlled by an Energy Management System (EMS) or Building Automation System (BAS). The Remote Setpoint can be driven by a current or voltage signal within the following ranges:

- 4-20 mA/1-5 Vdc
- 0-20 mA/0-5 Vdc

The factory default setting for the Remote Setpoint mode is 4 - 20 mA/1 - 5 Vdc. With this setting, a 4 to 20 mA/1 to 5 Vdc signal, sent by an EMS or BAS, is used to change the unit's setpoint. The 4 mA/1V signal is equal to a 40°F setpoint while a 20 mA/5V signal is equal to a 240°F setpoint. When a 0 to 20 mA/0 to 5 Vdc signal is used, 0 mA is equal to a 40°F setpoint.

In addition to the current and voltage signals described above, the Remote Setpoint mode can also driven by a RS-485 Modbus Network signal from an EMS or BAS.

The Remote Setpoint modes of operation can be used to drive single as well as multiple units.

NOTE

If a voltage, rather than current signal is used to control the remote setpoint, a DIP switch adjustment must be made on the PMC Board located in the Control Panel Assembly. Contact your local AERCO representative for details.

In order to enable the Remote Setpoint Mode, the following menu setting must be made in the Configuration Menu:

Table 5-2: Remote Setpoint Mode Settings

Menu Option	Setting
Boiler Mode	Remote Setpoint
Remote Signal	4-20mA/1-5V, 0-20mA/0-5V, or Network

Refer to section 3.3 for detailed instructions on changing menu options.

If the Network setting is selected for RS-485 Modbus operation, a valid Comm Address must be entered in the Setup Menu. Refer to Modbus Communication Manual GF-114 for additional information.

CHAPTER 5 – MODE OF OPERATION

While it is possible to change the settings of temperature related functions, the unit is factory preset with settings that work well in most applications. It is suggested that an AERCO representative be contacted, prior to changing any temperature related function settings. For descriptions of temperature-related functions and their factory defaults, refer to Appendices A and E.

5.4.1 Remote Setpoint Field Wiring

The only wiring connections necessary for the Remote Setpoint mode are connection of the remote signal leads from the source to the unit's I/O Box. The I/O Box is located on the front panel of the boiler. For either a 4-20mA/0-5V or a 0-20mA/0-5V setting, the connections are made at the ANALOG IN terminals in the I/O Box. For a Network setting, the connections are made at the RS-485 COMM terminals in the I/O Box. The signal must be floating, (ungrounded) at the I/O Box and the wire used must be a two wire shielded pair from 18 to 22 AWG. Polarity must be observed. The source end of the shield must be connected at the source. When driving multiple units, each unit's wiring must conform to the above.

5.4.2 Remote Setpoint Startup

Since this mode of operation is factory preset and the setpoint is being externally controlled, no startup instructions are necessary. In this mode, the **REMOTE** LED will light when the external signal is present.

To operate the unit in the Manual mode, press the **AUTO/MAN** switch. The **REMOTE** LED will go off and the **MANUAL** LED will light.

To change back to the Remote Setpoint mode, simply press the **AUTO/MAN** switch. The **REMOTE** LED will again light and the **MANUAL** LED will go off.

5.5 DIRECT DRIVE MODES

The unit's air/fuel valve position (% open) can be changed by a remote signal which is typically sent from an Energy Management System (EMS) or from a Building Automation System (BAS). The Direct Drive mode can be driven by a current or voltage signal within the following ranges:

- 4-20 mA/1-5 Vdc
- 0-20 mA/0-5 Vdc

The factory default setting for the Direct Drive mode is 4-20 mA/1-5 Vdc. With this setting, a 4 to 20 mA signal, sent by an EMS or BAS is used to change the unit's valve position from 0% to 100%. A 4 mA/1V signal is equal to a 0% valve position, while a 20 mA/5V signal is equal to a 100% valve position. When a 0-20 mA/0-5 Vdc signal is used, zero is equal to a 0% valve position.

In addition to the current and voltage signals described above, the Direct Drive mode can also be driven by a RS-485 Modbus Network signal from an EMS or BAS.

When in a Direct Drive mode, the unit is a slave to the EMS or BAS and does not have a role in temperature control. Direct Drive can be used to drive single, or multiple units.

NOTE

If a voltage, rather than current signal is used to control the remote setpoint, a DIP switch adjustment must be made on the CPU Board located in the Control Box Assembly. Contact your local AERCO representative for details.

CHAPTER 5 - MODE OF OPERATION

To enable the Direct Drive Mode, the following menu setting must be made in the Configuration Menu:

Table 5-3: Direct Drive Mode Settings

Menu Option	Setting
Boiler Mode	Direct Drive
Remote Signal	4-20mA/1-5V,
	0-20mA/0-5V, or Network

Refer to section 3.3 for instructions on changing menu options.

If the Network setting is selected for RS-485 Modbus operation, a valid Comm Address must be entered in the Setup Menu. Refer to Modbus Communication Manual GF-114 for additional information.

5.5.1 Direct Drive Field Wiring

The only wiring connections necessary for Direct Drive mode are connection of the remote signal leads from the source to the unit's I/O Box. For either a 4-20mA/0-5V or a 0-20mA/0-5V setting, the connections are made at the ANALOG IN terminals in the I/O Box. For a Network setting, the connections are made at the RS-485 COMM terminals in the I/O Box. The signal must be floating, (ungrounded) at the I/O Box and the wire used must be a two wire shielded pair from 18 to 22 AWG. Polarity must be observed. The source end of the shield must be connected at the source. When driving multiple units, each unit's wiring must conform to the above.

5.5.2 Direct Drive Startup

Since this mode of operation is factory preset and the valve position is being externally controlled, no startup instructions are necessary. In this mode, the **REMOTE** LED will light when the signal is present.

To operate the unit in manual mode, press the **AUTO/MAN** switch. The **REMOTE** LED will go off and the **MANUAL** LED will light.

To change back to the Direct Drive mode, simply press the **AUTO/MAN** switch. The **REMOTE** LED will again light and the **MANUAL** LED will go off.

5.6 AERCO CONTROL SYSTEM (ACS)

NOTE

ACS is for installations with 9 or more boilers. It utilizes only RS-485 signaling to the boiler. Installations with 1 to 8 boilers can use BST (see Chapter 10).

The ACS mode of operation is used in conjunction with the AERCO Control System. The ACS mode is used when it is desired to operate multiple units in the most efficient manner possible. For this mode of operation, an ACS Header Sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the boiler plant's supply water header. The ACS can control up to 40 boilers; up to 32 via Modbus (RS-485) network communication. For ACS programming,

CHAPTER 5 - MODE OF OPERATION

operation, and Header Sensor installation details, see ACS Operations Guide, GF-131. For operation via an RS-485 Modbus network, refer to Modbus Communication Manual GF-114.

To enable the ACS Mode, the following menu settings must be made in the Configuration Menu:

Table 5-4: ACS Mode Settings

Menu Option	Setting
Boiler Mode	Direct Drive
Remote Signal	Network (RS-485)

Refer to section 3.3 for instructions on changing menu options.

5.6.1 ACS External Field Wiring

Wiring connections for RS-485 Modbus control are made between the 485 A- and 485 B+ terminals on the ACS (boilers 9 through 40), and the RS-485 COMM terminals in the I/O Box on the front of the boilers.

Wire the units using shielded twisted pair wire between 18 and 22 AWG. Observe the proper polarity for the ACS RS-485 COMM wiring connections. Shields should be terminated only at the ACS and the boiler end must be left floating. Each unit's wiring must conform to the above.

5.6.2 ACS Setup and Startup

This mode of operation is factory preset and the ACS controls the firing rate (air/fuel valve % open position). There are no setup instructions for each individual unit.

To operate the unit in manual mode, press the **AUTO/MAN** switch. The **REMOTE** LED will go off and the **MANUAL** LED will light

To change back to ACS mode, simply press the **AUTO/MAN** switch. The **REMOTE** LED will again light and the **MANUAL** LED will go off.

5.7 COMBINATION CONTROL SYSTEM (CCS)

NOTE

Only ACS can be utilized for the Combination Control System.

A Combination Control System (CCS) is one that uses multiple boilers to cover both spaceheating and domestic hot water needs. An AERCO Control System (ACS) and An optional ACS Relay Box are necessary to configure this system. Typically, an adequate number of boilers are installed to cover the space-heating load on the design day, however one or more units are used for the domestic hot water load.

The theory behind this type of system is that the maximum space-heating load and the maximum domestic hot water load do not occur simultaneously. Therefore, boilers used for domestic hot water are capable of switching between constant setpoint and ACS control.

For a typical CCS, an adequate number of boilers are installed to cover the space-heating load on the design-day. However, one or more units are used for the domestic hot water load as well. These boilers are the combination units and are referred to as the combo boilers. The combo boilers heat water to a constant setpoint temperature. That water is then circulated through a heat exchanger in a domestic hot water storage tank.

CHAPTER 5 – MODE OF OPERATION

Only the AERCO Control System (ACS) is necessary to configure this system if only a single valve is used to switch from space heating to domestic hot water. However, the ACS Relay Panel is required in combination with the ACS when there are up to two isolation valves, boiler interlocks, and/or a Domestic Hot Water (DHW) pump in a Combination heating plant where AERCO boilers are being used for both Building Heat and Domestic Hot Water heating.

The following two options are available for using a combination system; one that uses only the ACS, and one that requires the optional ACS Relay Box:

- **OPTION 1** This option is selected when the ACS controls a boiler plant containing up to eight combination boilers that are Domestic Hot Water Priority (DHW PRIORITY) boilers, along with building heat (BLDG HEAT) boilers, and *one* hydronic isolation valve in the main header between the BLDG HEAT boilers and the DHW PRIORITY boilers.
- OPTION 2 When this option is selected, the ACS Relay Panel must be used in conjunction with the ACS. For this option, the ACS controls a boiler plant containing up to eight combination boilers that are divided up into Building Priority (BLDG PRIORITY) boilers and Domestic Hot Water Priority (DHW PRIORITY) boilers, along with building heat (BLDG HEAT) boilers, and using two hydronic isolation valves in the main header, one between the BLDG HEAT and BLDG PRIORITY boilers, and the other between the BLDG PRIORITY and the DHW PRIORITY boilers.

In Option 2, when the space-heating load is such that when all the space-heating boilers are at the 100% valve position, the ACS will then ask the ACS Relay Box for the domestic boilers to become space-heating boilers. Provided the domestic hot water load is satisfied, the combo (hot water) boilers will then become space-heating boilers. If the domestic hot water load is not satisfied, the combo boiler(s) remain on the domestic hot water load. If the combo boilers switch over to space heating, but there is a call for domestic hot water, the ACS Relay Box switches the combo units back to the domestic load. The ACS in combination with the ACS Relay Box will ask the BLDG PRIORITY boilers to help with domestic hot water heating if the DHW PRIORITY boilers are not able to satisfy the domestic hot water demand.

When the combo units are satisfying the domestic load, they are in the constant setpoint mode of operation. When the combo units switch over to space heating, their mode of operation changes to follow the ACS command. For more information concerning the operation of the ACS, consult the ACS Operations Guide, GF-131. For more information on the ACS Relay Box, see section 2.14 in the same manual.

5.7.1 Combination Control System Field Wiring

Wiring for this system is between the ACS, the ACS Relay Box and the terminals in the I/O Box. Wire the units using a shielded twisted pair of 18 to 22 AWG wire. When wiring multiple units, each unit's wiring must conform to the above.

5.7.2 Combination Control System Setup and Startup

Setup for the Combination Mode requires entries to be made in the Configuration Menu for boiler mode, remote signal type and setpoint. The setpoint is adjustable from 40°F to 190°F.

Enter the following settings in the Configuration Menu:

CHAPTER 5 - MODE OF OPERATION

Table 5-5: Combination Mode Settings

Menu Option	Setting
Boiler Mode	Combination
Remote Signal	Network
Internal Setpt	40°F to 190°F

Refer to section 3.3 for instructions on changing menu options.

While it is possible to change other temperature-related functions for combination mode, these functions are preset to their factory default values. These default settings work well in most applications. It is suggested that AERCO be contacted prior to changing settings other than the unit's setpoint. For a complete listing of temperature related function defaults, see Appendix E.

To set the unit to the manual mode, press the AUTO/MAN switch. The MANUAL LED will light.

To set the unit back to the auto mode, press the **AUTO/MAN** switch. The **MANUAL** LED will go off and the **REMOTE** LED will light.

When the boiler is switched to ACS control, the ACS controls the valve position. There are no setup requirements to the boiler(s) in this mode.

CHAPTER 6. SAFETY DEVICE TESTING

6.1 TESTING OF SAFETY DEVICES

Periodic safety device testing is required to ensure that the control system and safety devices are operating properly. The boiler control system comprehensively monitors all combustion-related safety devices before, during and after the start sequence. The following tests check to ensure that the system is operating as designed.

Operating controls and safety devices should be tested on a regular basis or following service or replacement. All testing must conform to local codes such as ASME CSD-1.

NOTE

MANUAL and AUTO modes of operation are required to perform the following tests. For a complete explanation of these modes, see Chapter 3.

NOTE

It will be necessary to remove the front door and side panels from the unit to perform the following tests.

△ WARNING **△**

ELECTRICAL VOLTAGES IN THIS SYSTEM MAY INCLUDE 120 AND 24 VOLTS AC. POWER MUST BE REMOVED PRIOR TO PERFORMING WIRE REMOVAL OR OTHER TEST PROCEDURES THAT CAN RESULT IN ELECTRICAL SHOCK.

OMM-0082_0J GF-130

6.2 LOW GAS PRESSURE FAULT TEST

Refer to Figure 6-1A and ensure that the leak detection ball valve located at the High Gas Pressure switch is closed on both the Natural Gas and Propane gas trains.

Low Gas Pressure Fault Test

- 1. Remove the 1/4" plug from the leak detection ball valve at the Low Gas Pressure switch, shown in Figure 6-1A.
- 2. Install a 0 16" W.C. manometer or a W.C. gauge where the 1/4" plug was removed.
- 3. Slowly open the ball valve near the Low Gas Pressure switch.
- 4. Place the unit in Manual Mode and adjust the Air/Fuel Valve position (% open) between **25** and **30**%.
- 5. While the unit is firing, slowly close the external manual gas shut-off valve.
- 6. The unit should shut down and display a *GAS PRESSURE* fault message, and the FAULT indicator should also start flashing at the following approximate pressures:
 - BMK 750 & 1000 NATURAL GAS gas trains: 2.6" W.C.
 - **BMK 750** PROPANE gas train: **4.4**" **W.C.**
 - BMK 1000 PROPANE gas train: 7.5" W.C.
- 7. Fully open the external manual gas shut-off valve and press the **CLEAR** button on the Control Box.
- 8. The fault message should clear, the FAULT indicator should go off and the unit should restart.
- 9. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4" plug removed in step 1.

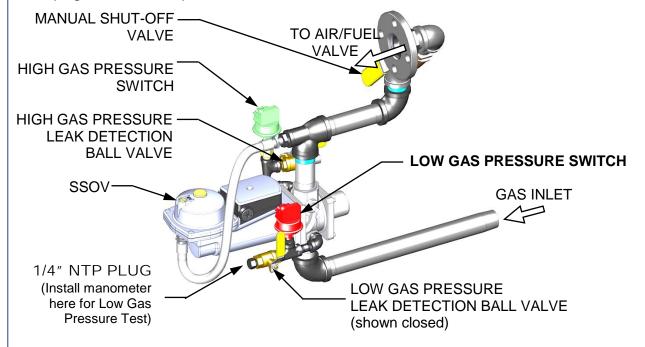


Figure 6-1A: Low Gas Pressure Fault Test – Natural Gas gas train shown

6.3 HIGH GAS PRESSURE TEST

The instructions below apply to both the Natural Gas and Propane gas trains.

To simulate a high gas pressure fault, refer to Figure 6-1B and perform the following steps:

High Gas Pressure Test

- 1. Remove the 1/4" plug from the leak detection ball valve at the High Gas Pressure switch, shown in Figure 6-1B.
- 2. Install a 0 16° W.C. manometer (or W.C. gauge) where the 1/4° plug was removed.
- 3. Slowly open the leak detection ball valve near the High Gas Pressure switch.
- 4. Start the unit in Manual mode at a valve position (firing rate) between **25** and **30**%.
- 5. With the unit running, monitor the gas pressure on the manometer installed in step 2 and record the gas pressure reading.
- 6. Slowly increase the gas pressure using the adjustment screw on the SSOV (see Figure 4-3 in Chapter 4).
- 7. The unit should shut down and display a *GAS PRESSURE* fault message, and the FAULT indicator should also start flashing at the following approximate pressures:
 - BMK 750 & 1000 NATURAL GAS gas trains: 4.7" W.C.
 - BMK 750 PROPANE gas train: 4.7" W.C.
 - BMK 1000 PROPANE gas train: 10.5" W.C.
- 8. Reduce the gas pressure back to the value recorded in step 5. This pressure should be within the range of
 - BMK 750 & 1000 NATURAL GAS gas trains: 2.0" W.C. ± 0.4" W.C.
 - BMK 750 PROPANE gas train: 3.9" W.C. ± 0.2" W.C.
 - BMK 1000 PROPANE gas train: 7.4" W.C. ± 0.2" W.C.
- 9. Press the CLEAR button on the Control Box to clear the fault.
- 10. The fault message should clear and the **FAULT** indicator should go off. The unit should restart.
- 11. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4"plug removed in step 1.

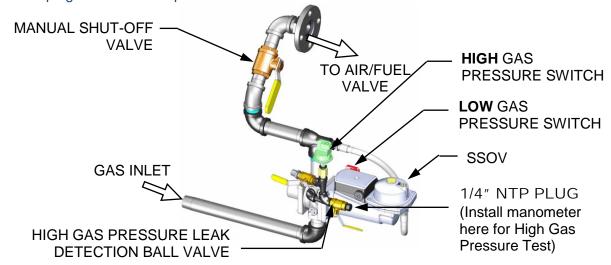


Figure 6–1B: High Gas Pressure Test – Natural Gas gas train shown

CHAPTER 6 - SAFETY DEVICE TESTING

6.4 LOW WATER LEVEL FAULT TEST

To simulate a low water level fault, proceed as follows:

Low Water Level Fault Test

- 1. Set the **ON/OFF** switch to the **OFF** position
- 2. Close the water shut-off valves in the supply and return piping to the unit.
- 3. Slowly open the drain valve on the rear of the unit. If necessary the unit's relief valve may be opened to aid in draining.
- 4. Continue draining the unit until a **LOW WATER LEVEL** fault message is displayed and the **FAULT** indicator flashes.
- 5. Place the unit in the Manual Mode and raise the valve position above 30%.
- 6. Set the **ON/OFF** switch to the **ON** position. The **READY** light should remain off and the unit should not start. If the unit does start, shut the unit off immediately and refer fault to qualified service personnel.
- 7. Close the drain and pressure relief valve used in draining the unit.
- 8. Open the water shut-off valve in the return piping to the unit.
- 9. Open the water supply shut-off valve to the unit to refill.
- 10. After the shell is full, press the **LOW WATER LEVEL RESET** button to reset the low water cutoff.
- 11. Press the **CLEAR** button to reset the **FAULT** LED and clear the displayed error message.
- 12. Set the **ON/OFF** switch to the **ON** position. The unit is now ready for operation.

6.5 WATER TEMPERATURE FAULT TEST

A high water temperature fault is simulated by adjusting the automatic over-temperature switch. This switch is accessible from the front of the unit as shown in Figure 6-2.

Water Temperature Fault Test

- 1. Start the unit in the normal operating mode. Allow the unit to stabilize at its setpoint.
- 2. Lower the adjustable over-temperature switch setting to match the displayed OUTLET TEMPERATURE.
- Once the adjustable over-temperature switch setting is approximately at, or just below, the actual outlet water temperature, the unit should shut down. The FAULT indicator should start flashing and a HIGH WATER TEMP SWITCH OPEN fault message should be displayed. It should not be possible to restart the unit.
- 4. Reset the adjustable over-temperature switch to its original setting.
- 5. The unit should start once the adjustable temperature limit switch setting is above the actual outlet water temperature.
- 6. Once the adjustable over-temperature switch setting is approximately at, or just below, the actual outlet water temperature, the unit should shut down. The FAULT indicator should start flashing and a HIGH WATER TEMP SWITCH OPEN fault message should be displayed. It should not be possible to restart the unit.
- 7. Reset the adjustable over-temperature switch to its original setting.
- 8. The unit should start once the adjustable temperature limit switch setting is above the actual outlet water temperature.

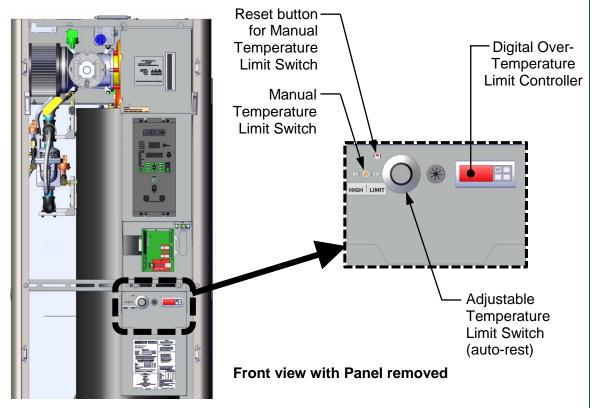


Figure 6-2: Temperature Limit Switch Location and Setting

CHAPTER 6 - SAFETY DEVICE TESTING

6.6 INTERLOCK TESTS

The unit is equipped with two interlock circuits called the Remote Interlock and Delayed Interlock. Terminal connections for these circuits are located in the I/O Box (Figure) and are labeled REMOTE INTL'K IN and DELAYED INTL'K IN. These circuits can shut down the unit in the event that an interlock is opened. These interlocks are shipped from the factory jumpered (closed). However, each of these interlocks may be utilized in the field as a remote stop and start, an emergency cut-off, or to prove that a device such as a pump, gas booster, or louver is operational.

6.6.1 Remote Interlock Test

Remote Interlock Test

- 1. Remove the cover from the I/O Box and locate the REMOTE INTL'K IN terminals.
- 2. Start the unit in the Manual Mode and set the valve position between 25% and 30%.
- 3. If there is a jumper across the REMOTE INTL'K IN terminals, remove one side of the jumper. If the interlock is being controlled by an external device, either open the interlock via the external device or disconnect one of the wires leading to the external device.
- 4. The unit should shut down and display INTERLOCK OPEN.
- 5. Once the interlock connection is reconnected, the *INTERLOCK OPEN* message should automatically clear and the unit should restart.

6.6.2 Delayed Interlock Test

Delayed Interlock Test

- 1. Remove the cover from the I/O Box and locate the DELAYED INTL'K IN terminals.
- 2. Start the unit in the Manual Mode at a valve position between 25% and 30%.
- 3. If there is a jumper across the DELAYED INTL'K IN terminals, remove one side of the jumper. If the interlock is connected to a proving switch of an external device, disconnect one of the wires leading to the proving switch.
- 4. The unit should shut down and display a **DELAYED INTERLOCK OPEN** fault message. The **FAULT** LED should be flashing.
- 5. Reconnect the wire or jumper removed in step 3 to restore the interlock.
- 6. Press the **CLEAR** button to reset the fault
- 7. The unit should start.

6.7 FLAME FAULT TESTS

Flame faults can occur during ignition or while the unit is already running. To simulate each of these fault conditions, proceed as follows:

Flame Fault Tests

- 1. Set the **ON/OFF** switch to the **OFF** position.
- 2. Place the unit in the Manual Mode and set the valve position between 25% and 30%.
- 3. Close the manual gas shutoff valve located between the Safety Shut-Off Valve (SSOV) and the Air/Fuel Valve (see Figure 6-3).
- 4. Set the **ON/OFF** switch to the **ON** position to start the unit.
- 5. The unit should shut down after reaching the Ignition cycle and display **FLAME LOSS DURING IGN**.
- 6. Open the valve previously closed in step 3 and press the **CLEAR** button.
- 7. Restart the unit and allow it to prove flame.
- 8. Once flame is proven, close the manual gas valve located between the SSOV (Figure 6-3) and the Air/Fuel Valve.
- 9. The unit should shut down and execute an *IGNITION RETRY* cycle by performing the following steps:
 - a) The unit will execute a shutdown purge cycle for a period of 15 seconds and display **WAIT FAULT PURGE**.
 - b) The unit will execute a 30 second re-ignition delay and display **WAIT RETRY PAUSE**.
 - c) The unit will then execute a standard ignition sequence and display **WAIT IGNITION RETRY**.
- 10. Since the manual gas shutoff valve is still closed, the unit will fail the ignition retry sequence. Therefore, it will shut down and display **FLAME LOSS DURING IGNITION** following the failed **IGNITION** RETRY cycle.
- 11. Open the valve previously closed in step 8.
- 12. Press the **CLEAR** button. The unit should restart and fire.

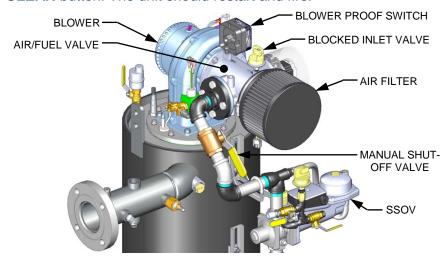


Figure 6-3: Bare Boiler – Partial View

CHAPTER 6 - SAFETY DEVICE TESTING

6.8 AIR FLOW FAULT TESTS

These tests check the operation of the Blower Proof Switch and Blocked Inlet Switch shown in Figure 6-3.

6.8.1 Blower Proof Switch Test

Blower Proof Switch Test

- 1. Disable the blower output drive voltage as follows:
 - a) Press the **MENU** key until *CONFIGURATION MENU* is displayed.
 - b) Press the ▲ arrow key until the *ANALOG OUTPUT* function is displayed, then press the **CHANGE** key.
 - c) Press the ▼ arrow key until *OFF* is displayed, then press the **ENTER** key.
- 2. Start the unit in the Manual Mode at a valve position between 25% and 30%.
- 3. The unit should shut down and lockout, showing AIRFLOW FAULT DURING PURGE in the display.
- 4. The unit should perform one *IGNITION RETRY* cycle and then shut down, since the blower is disabled. The unit will then display *AIRFLOW FAULT DURING PURGE*.
- 5. Re-enable the blower output drive voltage by performing the following steps:
 - a) Press the **MENU** key until *CONFIGURATION MENU* is displayed.
 - b) Press the ▲ arrow key until the *ANALOG OUTPUT* function is displayed, then press the **CHANGE** key.
 - c) Press the ▲ arrow key until *VALVE POSITION 0-10V* is displayed, then press the **ENTER** key.
 - d) Press the **CLEAR** button to clear the airflow fault.
- 6. Once the unit has proved flame, turn off the blower again by going to the Configuration Menu, *Analog Output* menu item and select **OFF**.
- 7. The Blower Proof Switch will open and the blower should stop. The unit should shut down and display *AIRFLOW FAULT DURING RUN*.
- 8. Go to the Configuration Menu, Analog Output item and select VALVE POSITION 0-10v.

6.8.2 Blocked Inlet Switch Test

This test will be run in simulated fire mode, with the Blocked Inlet Switch isolated from the rest of the control circuitry.

Blocked Inlet Switch Test

- 1. Turn off the main ON/OFF switch on the front of the Control Panel.
- 2. For units that get combustion air from a Combustion Air Duct, remove that duct, located on the rear panel of the boiler (see Figure 6.4, below). For units that have an air filter in place of a Combustion Air Duct (not shown), remove the air filter.

CHAPTER 6 - SAFETY DEVICE TESTING

Blocked Inlet Switch Test - Continued

WARNING

THE BLOWER SUCTION IS VERY STRONG AND CAN PULL NEARBY OBJECTS INTO THE BLOWER'S FAN BLADES. DO ALLOW ANYTHING TO BE PULLED INTO THE BLOWER. DO NOT WEAR ANYTHING THAT COULD GET CAUGHT AND PULL YOU INTO THE BLOWER.

- 3. Turn off the gas supply ball valve to the boiler and then complete the following steps:
 - Use jumper wires to jump out the Low Gas Pressure Switch and the Blower Proof Switch.
 - b) Remove the black connector boot from the Flame Detector.
 - c) Connect the Flame Signal Generator to the black connector boot.

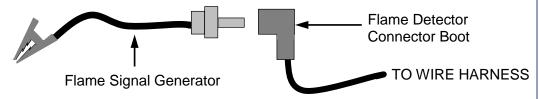


Figure 6.3a: Connecting the Flame Signal Generator

- (d) Keep the alligator clip away from bare metal parts until step 4c.
- 4. Complete the following with the boiler operating in Manual mode:
 - a) Ramp the boiler up to 100% fire rate and then turn on the main ON/OFF switch on the front of the Control Panel.
 - b) Push the **BACK** button three (3) times to return to the upper level menu.
 - c) When the Controller gets into the ignition phase, the Control Panel will show *IGNITION TRIAL*. At that point attach the alligator clip (see Figure 6.3a) to any bare metal surface or ground. The C-More display should now show *FLAME PROVEN* and begin to ramp up to 100% fire rate. Note that no gas or flame is present in the boiler at this time.
- 5. Wait for the boiler to ramp up to at least 90% before continuing.
- 6. Cover the combustion air inlet opening with a solid, flat object, such as a piece of thick plywood or a thick metal plate.
- 7. The unit should shut down and display AIRFLOW FAULT DURING RUN. This step confirms proper operation of the Blocked Inlet Switch.
- 8. Remove the cover from the air inlet opening and reinstall the Combustion Air Duct or air filter.
- 9. Remove the jumper wires installed in step 2 and replace the black connector boot on the Flame Detector.
- 10. Press the **CLEAR** button. The unit should restart.

CHAPTER 6 - SAFETY DEVICE TESTING

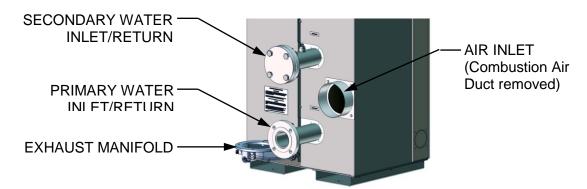


Figure 6-4: Boiler Rear View Showing Air Inlet Location

6.9 SSOV PROOF OF CLOSURE SWITCH

The SSOV shown in Figure 6-1 contains the proof of closure switch. The proof of closure switch circuit is checked as follows:

SSOV Proof of Closure Switch

- 1. Set the unit's **ON/OFF** switch to the **OFF** position.
- 2. Place the unit in Manual Mode and set the valve position between 25% and 30%
- 3. Refer to Figure 6-3 and locate the SSOV.
- 4. Remove the cover from the SSOV by loosening the screw shown in Figure 6-5. Lift off the cover to access the terminal wiring connections.
- 5. Disconnect wire #148 from the SSOV to "open" the proof of closure switch circuit.
- 6. The unit should fault and display SSOV SWITCH OPEN.
- 7. Replace wire #148 and press the **CLEAR** button.
- 8. Set the **ON/OFF** switch to the **ON** position to start the unit.
- 9. Remove the wire again when the unit reaches the purge cycle and **PURGING** is displayed.
- 10. The unit should shut down and display **SSOV FAULT DURING PURGE**.
- 11. Replace the wire on the SSOV and press the CLEAR button. The unit should restart.



Figure 6-5: SSOV Actuator Cover Location

6.10 PURGE SWITCH OPEN DURING PURGE

The Purge Switch (and Ignition Switch) is located on the Air/Fuel Valve. To check the switch, proceed as follows:

Purge Switch Open During Purge

- 1. Set the unit's **ON/OFF** switch to the **OFF** position. Place the unit in manual mode and set the valve position between 25% and 30%.
- 2. Remove the Air/Fuel Valve cover by rotating the cover counterclockwise to unlock it (see Figure 6-6).
- 3. Remove one of the two wires (#171 or #172) from the Purge Switch (Figure 6-6).
- 4. Initiate a unit start sequence.
- 5. The unit should begin its start sequence, then shut down and display PRG SWITCH OPEN DURING PURGE.
- 6. Replace the wire on the Purge Switch and depress the **CLEAR** button. The unit should restart.



Figure 6-6: Air/Fuel Valve Cover Location

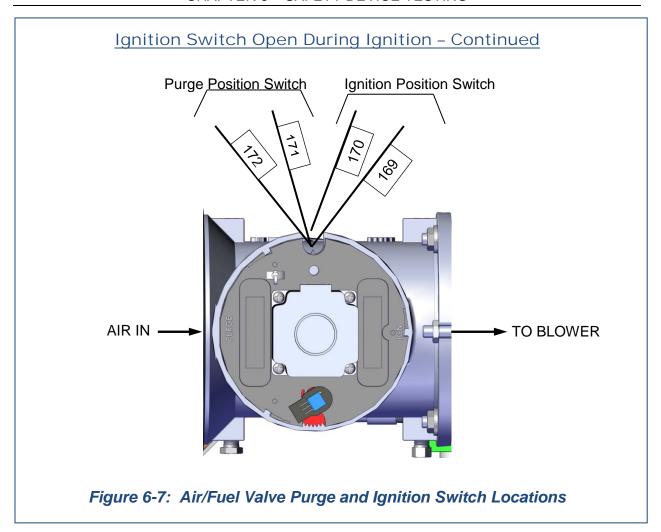
6.11 IGNITION SWITCH OPEN DURING IGNITION

The Ignition Switch (and the Purge Switch) is located on the Air/Fuel Valve. To check the switch, proceed as follows:

Ignition Switch Open During Ignition

- 1. Set the unit's **ON/OFF** switch to the **OFF** position.
- 2. Place the unit in Manual Mode and set the valve position between 25% and 30%.
- 3. Remove the Air/Fuel Valve cover (Figure 6-6) by rotating the cover counterclockwise to unlock and lift up to remove.
- 4. Remove one of the two wires (#169 or #170) from the Ignition Switch (Figure 6-7).
- 5. Initiate a unit start sequence.
- 6. The unit should begin its start sequence and then shut down and display *IGN SWITCH OPEN DURING IGNITION*.
- 7. Replace the wire on the Ignition Switch and press the **CLEAR** button. The unit should restart.

CHAPTER 6 – SAFETY DEVICE TESTING



6.12 SAFETY PRESSURE RELIEF VALVE TEST

Test the safety Pressure Relief Valve in accordance with ASME Boiler and Pressure Vessel Code, Section VI.

CHAPTER 7. MAINTENANCE

7.1 MAINTENANCE SCHEDULE

The unit requires regular routine maintenance to keep up efficiency and reliability. For best operation and life of the unit, the following routine maintenance procedures should be performed in the time periods specified in Table 7-1. For a complete inspection check list see ASME CSD-1 chart.

In order to perform the maintenance tasks specified in Table 7-1, the following maintenance kits are available through your local AERCO Sales Representative:

- Annual Maintenance Kit, Part No. 58025-01
- 24-Month Waterside/Fireside Inspection Kit, Part No. 58025-08 (See NOTE below)

NOTE

The 24-Month Waterside/Fireside Inspection Kit also includes the items contained in the Annual Maintenance Kit (58025-01). Therefore, only Kit Part No. 58025-08 is required when performing the waterside/fireside inspections. Refer to Appendix L for recommended spare.

△ WARNING **△**

TO AVOID PERSONAL INJURY, PRIOR TO SERVICING ENSURE THAT THE FOLLOWING GUIDELINES ARE STRICTLY OBSERVED:

- DISCONNECT THE AC SUPPLY BY TURNING OFF THE SERVICE SWITCH AND AC SUPPLY CIRCUIT BREAKER.
- SHUT OFF THE GAS SUPPLY AT THE MANUAL SHUT-OFF VALVE PROVIDED WITH THE UNIT
- ALLOW THE UNIT TO COOL TO A SAFE WATER TEMPERATURE TO PREVENT BURNING OR SCALDING

Table 7-1: Maintenance Schedule

Section	Item	6 Mos.	12 Mos.	24 Mos.	Labor Time
7.2	Igniter-Injector Kit (58023)	*Inspect	Inspect	Replace	15 mins.
7.3	Flame Detector Kit (24356-1)	*Inspect	Inspect	Replace	15 mins.
7.4	Lean O ₂ Sensor (61026)	*Inspect	Inspect		15 mins.
7.5	Combustion Calibration	*Check	Check		1 hr.
7.6	Testing of Safety Devices		See ASME CSD-1 Chart		45 mins.
7.7	Burner			Inspect	2 hrs.
7.8	Condensate Drain Trap	*Inspect	Inspect, Clean & Replace Gaskets	Inspect, Clean & Replace Gaskets	30 mins.
7.9	Air Filter (59139)		Clean	Replace	15 mins.

^{*} Only performed after initial 6 month period after initial startup.

7.2 IGNITER-INJECTOR REPLACEMENT

The igniter-injector (P/N 58023) is located on the burner plate at the top of the boiler. In addition to providing the ignition spark required to light the burner, the igniter-injector also contains a gas injector tube which connects to the staged ignition assembly. Figure 7-1 shows the complete burner assembly removed from the boiler and indicates the location of the igniter-injector flame detector and other related components.

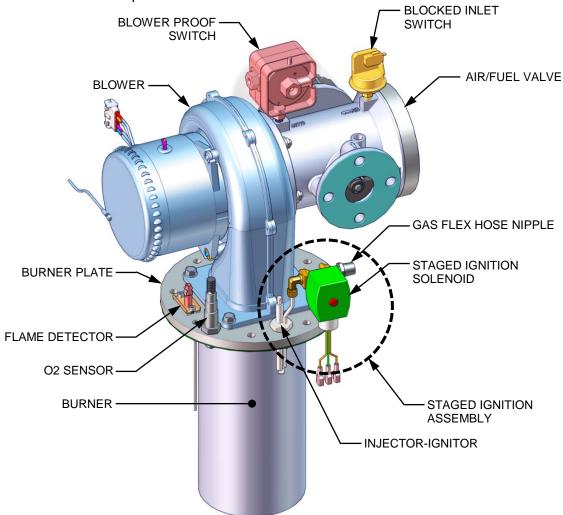


Figure 7-1: Benchmark Burner Assembly (Removed from Boiler)

The igniter-injector may be hot, therefore care should be exercised to avoid burns. It is easier to remove the igniter-injector from the unit after the unit has cooled to room temperature. To inspect/replace the Igniter:

Igniter-Injector Replacement

- 1. Set the **ON/OFF** switch on the control panel, to the **OFF** position. Disconnect AC power from the unit
- 2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.

CHAPTER 7 - MAINTENANCE

Igniter-Injector Replacement - Continued

- 3. Disconnect the cable from the igniter-injector (Figure 7-1).
- 4. Refer to the partial exploded view in Figure 7-2. Using a 7/16" open-end wrench, disconnect the compression nut securing the gas injector tube of the igniter-injector to the elbow of the staged ignition assembly. Disconnect the staged ignition assembly from the igniter-injector.
- 5. Next, loosen and remove the igniter-injector from the burner plate using a 1" open-end wrench.
- 6. Check the igniter-injector for evidence of erosion or carbon build-up. If there is evidence of substantial erosion or carbon build-up, the igniter-injector should be replaced. If carbon build-up is present, clean the component using fine emery cloth. Repeated carbon build-up is an indication that the combustion settings of the unit should be checked. Refer to Chapter 4 for combustion calibration procedures.

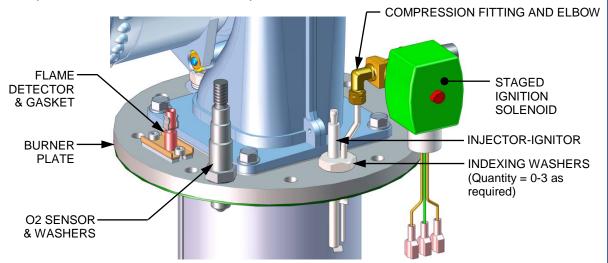


Figure 7-2: Igniter-Injector & Flame Detector Mounting Details

- 7. Next, loosen and remove the igniter-injector from the burner plate using a 1" open-end wrench.
- 8. Check the igniter-injector for evidence of erosion or carbon build-up. If there is evidence of substantial erosion or carbon build-up, the igniter-injector should be replaced. If carbon build-up is present, clean the component using fine emery cloth. Repeated carbon build-up is an indication that the combustion settings of the unit should be checked. Refer to Chapter 4 for combustion calibration procedures.
- 9. Prior to reinstalling the igniter-injector, a high temperature, conductive, anti-seize compound <u>must</u> be applied to the threads.

NOTF

If a replacement igniter-injector (part no. 58023) is being installed, a compression nut containing a built-in ferrule will be included with the replacement part. If needed, 3 indexing washers are also included These washers may be needed to properly position the gas injector tube of the igniter-injector within the 120° angle range shown in Figure 7-3.

CHAPTER 7 – MAINTENANCE

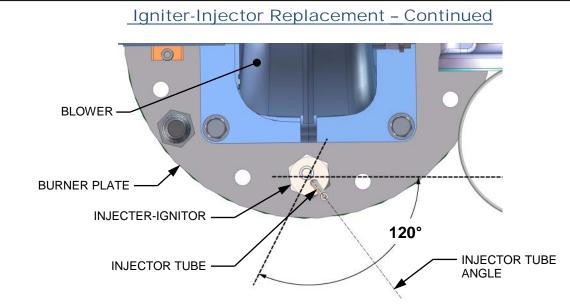


Figure 7-3: Igniter-Injector Orientation (Looking Down from Above)

- 10. Reinstall the igniter-injector in the burner plate. Torque to **170 180 in-lbs**. DO NOT over tighten.
- 11. Connect the staged ignition assembly to the gas injector tube of the igniter-injector by securing the compression nut to the elbow of the staged ignition assembly.
- 12. Reconnect the igniter-injector cable.
- 13. Reinstall the shroud on the unit.

7.3 FLAME DETECTOR REPLACEMENT

The flame detector (P/N 24356-1) is located on the burner plate at the top of the unit (see Figure 7-1 and Figure 7-2). The flame detector may be hot. Allow the unit to cool sufficiently before removing the flame detector. Inspect or replace the flame detector as follows:

Flame Detector Replacement

- 1. Set the control panel **ON/OFF** switch to the **OFF** position. Disconnect AC power from the
- 2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
- 3. Disconnect the flame detector lead wire.
- 4. Remove the two (2) screws securing the flame detector to the plate (Figure 7-2 on previous page). The flame detector is secured to the burner plate with one #10-32 screw and one #8-32 screw.
- 5. Remove the flame detector and gasket from the burner plate.
- 6. Thoroughly inspect the flame detector. If eroded, the detector should be replaced. Otherwise clean the detector with a fine emery cloth.
- 7. Reinstall the flame detector and flame detector gasket.
- 8. Reconnect the flame detector lead wire.
- 9. Reinstall the shroud on the unit.

CHAPTER 7 - MAINTENANCE

7.4 O₂ SENSOR REPLACEMENT

The Lean Oxygen Sensor (part no. 61026) is located on the burner plate at the top of the unit (see Figure 7-1 and Figure 7-2). The sensor and burner plate may be hot. Allow the unit to cool sufficiently before removing or replacing the O_2 sensor.

O₂ Sensor Replacement

- 1. Set the **ON/OFF** switch on the control panel, to the **OFF** position. Disconnect AC power from the unit.
- 2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
- 3. Disconnect the O₂ sensor lead wire by pushing in on the release tab and pulling apart the connector.
- 4. Next, loosen and remove the O_2 sensor and crush washer from the burner plate using a 15/16" open-end wrench.
- 5. Thoroughly inspect the O_2 sensor. If eroded, the sensor should be replaced. Otherwise clean the sensor with a fine emery cloth.
- 6. Reinstall the O_2 sensor and crush washer on the burner plate.
- 7. Reconnect the sensor lead wire.
- 8. Reinstall the shroud on the unit.

7.5 COMBUSTION CALIBRATION

Combustion settings must be checked at the intervals shown in Table 7-1 as part of the maintenance requirements. Refer to Chapter 4, section 4.3 for combustion calibration instructions.

7.6 SAFETY DEVICE TESTING

Systematic and thorough tests of the operating and safety devices should be performed to ensure that they are operating as designed. Certain code requirements, such as ASME CSD-1, require that these tests be performed on a scheduled basis. Test schedules must conform to local jurisdictions. The results of the tests should be recorded in a log book. See Chapter 6-Safety Device Testing Procedures.

7.7 BURNER ASSEMBLY INSPECTION

The burner assembly (part no. 24276) is located at the top of the unit's heat exchanger. The burner assembly may be hot. Therefore, allow the unit to cool sufficiently before removing the burner assembly. It should be noted that the complete burner assembly also includes the blower and air/fuel valve assemblies for the unit.

The following parts will be required for reassembly after burner inspection:

Part No.	<u>Description</u>	
81143	Burner Gasket	
81048	Flame Detector Gasket	
81064	Blower Gasket	

CHAPTER 7 – MAINTENANCE

To inspect or replace the burner assembly, proceed as follows:

Burner Assembly Inspection

- 1. Set the **ON/OFF** switch on the control panel, to the **OFF** position. Disconnect AC power from the unit and turn off the gas supply.
- 2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
- 3. Disconnect the lead wire from the flame detector installed on the burner plate. See Figure 7-2.
- 4. Remove the two (2) screws securing the flame detector to the plate. The flame detector is secured to the burner plate with one (1) #10-32 screw and one (1) #8-32 screw.
- 5. Remove the flame detector and gasket from the burner plate.
- 6. Disconnect the cable from the igniter-injector.
- 7. Using a 7/16" open-end wrench, disconnect the compression nut securing the gas injector tube of the igniter-injector to the elbow of the staged ignition assembly (see Figure 7-2). Disconnect the staged ignition assembly from the igniter-injector.
- 8. Next, loosen and remove the igniter-injector from the burner plate using a 1" open-end wrench.
- 9. Disconnect the unit wiring harness connectors from the air/fuel valve and blower motor.
- 10. Disconnect the wire leads connected to the blower proof switch and blocked inlet switch (Figure 7-4 and Figure 7-5).
- 11. Disconnect the gas train from the air/fuel valve by removing the four (4) 1/2" bolts and nuts (Figure 7-4).
- 12. Disconnect the flex hose from the air/fuel valve by loosening the hose clamp.
- 13. Remove the four 5/16-18 hex head screws securing the blower to the burner plate (Figure 7-5).
- 14. Remove the blower and air/fuel valve from the burner plate by lifting straight up. Also, remove the blower gasket.
- 15. Remove the eight (8) 3/8-16 nuts from the burner flange (Figure 7-4) using a 9/16" wrench.

CHAPTER 7 - MAINTENANCE

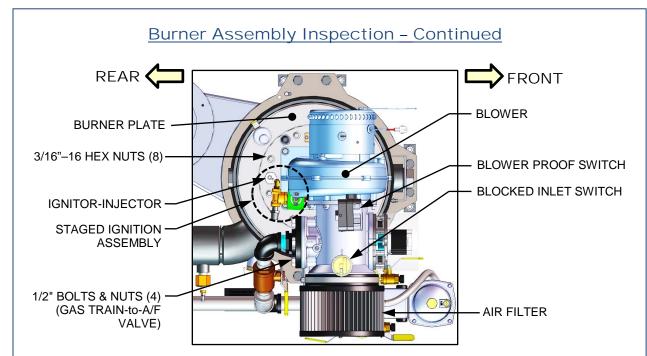
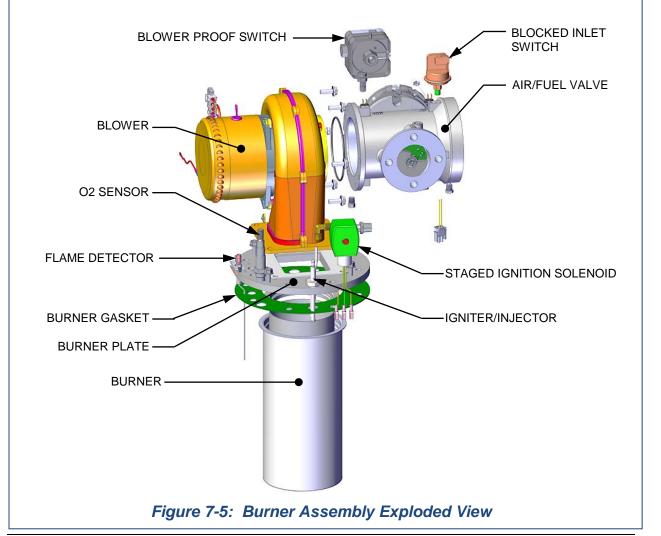


Figure 7-4: Burner Assembly Mounting Details - Overhead View



CHAPTER 7 – MAINTENANCE

Burner Assembly Inspection - Continued

NOTE

The burner assembly is heavy, weighing approximately 25 pounds.

- 16. Remove the burner assembly from burner flange by pulling straight up.
- 17. Remove and replace the burner gasket.

NOTE

During reassembly, apply a light coating of high-temperature, antiseize lubricant to the threads of the igniter-injector and grounding screw. Also, ensure that the igniter-injector is properly positioned as indicated in Figure 7-3. Torque the igniter-injector to 170 - 180 in-lbs.

- 18. Beginning with the burner assembly removed in step 16, reinstall all the components in the reverse order that they were removed. When reinstalling the burner flange (removed in step 15), tighten the 3/8-16 nuts using a typical torque pattern (for example, loosely tighten one nut, then loosely tighten a second nut on the opposite side, a third at 90 degrees to the first two, and a fourth opposite the third, and then repeat this pattern with the remaining four nuts. Repeat the entire pattern a second time to partially tighten all eight nuts, and then repeat a third time until all eight nuts are fully torqued to 22 ft. lbs).
- 19. Ensure that the igniter-injector and flame detector cutouts in the burner plate are properly aligned with the heat exchanger top flange.

7.8 CONDENSATE DRAIN TRAP MAINTENANCE

Benchmark boilers contain a condensate trap as shown in Chapter 2, Figure 2-6. The trap is located external to the unit and attached to the drain pipe from the exhaust manifold. This trap should be inspected and cleaned in accordance with the maintenance schedule shown in Table 7-1 to ensure proper operation. To inspect and clean the trap, proceed as follows:

Condensate Drain Trap Maintenance

- 1. Disconnect the external condensate trap by loosening the union pipe connection between the trap and the exhaust manifold drain pipe.
- 2. Remove the connections on the inlet and outlet sides of the condensate trap shown in Figure 7-6.
- 3. Loosen the four (4) thumbscrews securing the cover on the condensate trap. Remove the cover.
- 4. Remove the float from the condensate trap.
- 5. Remove the O-ring and orifice gaskets from the trap. AERCO recommends that these items be replaced annually.
- 6. Thoroughly clean the trap and float. Also inspect the drain piping for blockage. If the trap cannot be thoroughly cleaned, replace the trap.
- 7. After the above items have been inspected and thoroughly cleaned, replace the O-ring (84017) and orifice gasket (P/N 81092, if using older trap) with new parts.
- 8. Reassemble all piping and hose connections to the condensate trap inlet and outlet. Reconnect trap to exhaust manifold drain.

CHAPTER 7 – MAINTENANCE

Condensate Drain Trap Maintenance - Continued NOTE There are two slightly different types of condensate traps that may be used in your configuration; an older style with a separate inlet adapter, and a newer style with a built-in adapter (see Figure 7-6). Maintenance is the same, except that the newer style does not need an orifice gasket (Step 7). Thumb Screws SCREWS (4) 3/4" NPT COVER GASKET Condensate **FLOAT** Trap O-Ring **GUIDE** FLOAT Float Guide **INLET** Float Adapter Opening CONDENSATE O-Rings TRAP (2) (P/N 24060) **OUTLET** Figure 7-6: External Condensate Trap

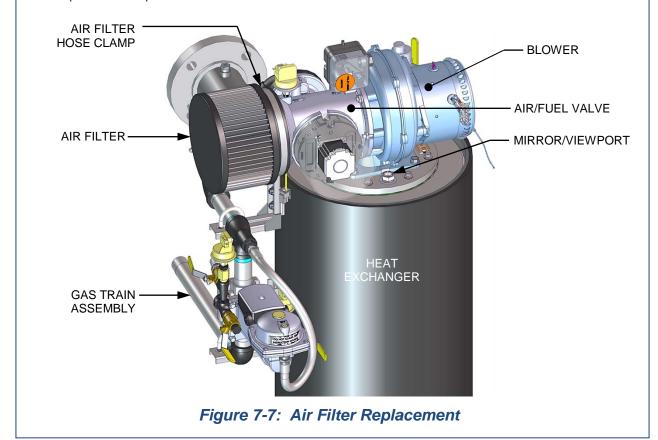
7.9 AIR FILTER CLEANING & REPLACEMENT

The Benchmark boiler is equipped with an air filter (P/N 59139) which should be cleaned and reoiled every 12 months and replaced every 24 months. The air filter is located at the inlet of the air fuel valve at the top of the boiler as shown in Figure 7-7.

To inspect/replace the air filter, proceed as follows:

Air Filter Cleaning & Replacement

- 1. Set the **ON/OFF** switch on the control panel, to the **OFF** position. Disconnect AC power from the unit.
- 2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
- 3. Refer to Figure 7-7 and locate the air filter attached to the air/fuel valve inlet.
- 4. Using a flat-tip screwdriver or 5/16" nut driver, loosen the clamp securing the filter to the inlet flange of the air/fuel valve. Remove the filter and clamp.
- 5. The filter may be cleaned in hot soapy water to remove oil and dirt. The filter should be thoroughly dried and then sprayed with a light coating of oil, such as WD-40, prior to reinstallation.
- 6. Each replacement air filter is equipped with its own clamp. Therefore, simply install the replacement air filter on inlet flange of the air fuel valve and tighten the clamp with a flat-tip screwdriver or 5/16" nut driver.
- 7. Replace the top shroud on the unit and return boiler to service use.



CHAPTER 7 - MAINTENANCE

7.10 SHUTTING THE BOILER DOWN FOR AN EXTENDED PERIOD OF TIME

If the boiler is to be taken out of service for an extended period of time (one year or more), the following instructions must be followed.

Shutting the Boiler Down for an Extended Period

- 1. Set **ON/OFF** switch on the front panel to the **OFF** position to shut down the boiler's operating controls.
- 2. Disconnect AC power from the unit.
- 3. Close the water supply and return valves to isolate boiler.
- 4. Close external gas supply valve.
- 5. Open relief valve to vent water pressure.

7.11 PLACING THE BOILER BACK IN SERVICE AFTER A PROLONGED SHUTDOWN

After a prolonged shutdown (one year or more), the following procedures must be followed:

Placing Boiler Back In Service After a Prolonged Shutdown

- 1. Review installation requirements included in Chapter 2.
- 2. Inspect all piping and connections to the unit.
- 3. Inspect exhaust vent and air inlet duct work (if applicable).
- 4. Perform initial startup per Chapter 4.
- 5. Perform safety device testing and scheduled maintenance procedures per Chapters 6 and 7 of this manual.

OMM-0082_0J GF-130

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 7 – MAINTENANCE (This Page Is Intentionally Blank)

CHAPTER 8. TROUBLESHOOTING GUIDE

8.1 INTRODUCTION

This troubleshooting guide is intended to aid service/maintenance personnel in isolating the cause of a fault in a Benchmark 750 MBH or 1000 MBH boiler. The troubleshooting procedures contained herein are presented in tabular form on the following pages. These tables are comprised of three columns labeled: Fault Indication, Probable Cause and Corrective Action. The numbered items in the Probable Cause and Corrective Action columns correspond to each other. For example, Probable Cause No. 1 corresponds to Corrective Action No. 1, etc.

NOTE

The front panel of the C-More Control Box contains an RS-232 port which can be interfaced to a laptop computer or other suitable device. This RS-232 communication feature permits service personnel to view menu items and data logs which can be useful in isolating faults. Refer to Chapter 9 of this manual for detailed RS-232 communication set-up and procedures.

When a fault occurs in the unit, proceed as follows to isolate and correct the fault:

<u>Troubleshooting Instructions</u>

- 1. Observe the fault messages displayed in the Control Box display.
- 2. Refer to the Fault Indication column in Troubleshooting Table 8-1 which follows and locate the Fault that best describes the existing conditions.
- 3. Proceed to the Probable Cause column and start with the first item (1) listed for the Fault Indication.
- 4. Perform the checks and procedures listed in the Corrective Action column for the first Probable Cause candidate.
- 5. Continue checking each additional Probable Cause for the existing fault until the fault is corrected.
- 6. Section 8.2 and Table 8-2 contain additional troubleshooting information which may apply when no fault message is displayed.

If the fault cannot be corrected using the information provided in the Troubleshooting Tables, contact your local AERCO Representative.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 8 – TROUBLESHOOTING GUIDE (This Page Is Intentionally Blank)

CHAPTER 8 – TROUBLESHOOTING GUIDE

Table 8-1 BOILER TROUBLESHOOTING

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Blower stopped running due to thermal or current overload.	Check combustion blower for signs of excessive heat or high current drain that may trip thermal or current overload devices.
	2. Blocked Blower inlet or inlet air filter.	2. Inspect the inlet to the combustion blower including the air filter at the air/fuel valve for signs of blockage.
	3. Blockage in Blower Proof switch.	3. Remove the Blower Proof switch and inspect for signs of blockage, clean or replace as necessary.
	4. Blockage in Blocked Inlet switch.	4. Remove the Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.
	5. Defective Blower Proof switch.	5. Check the continuity of the Blower Proof switch with the blower running. If the resistance reading is erratic or is greater than zero ohms, replace the switch.
	6. Defective Blocked Inlet switch.	6. Turn off unit and check the continuity of the Blocked Inlet switch. If the resistance reading is erratic or is greater than zero ohms, replace the switch.
AIRFLOW FAULT DURING IGNITION	7. Loose temperature to AUX connection	7. Check the actual inlet air temperature and measure voltage at AUX input in the I/O Box. Verify that the voltage conforms to the values shown in the tabular listing provided in Appendix C.
	in I/O Box.	8. Refer to CORRECTIVE ACTION 7 and verify that the voltage conforms to the values shown in Appendix C.
	8. Defective temperature sensor.	9. Check wire connection from I/O Box 0-10V signal to the Blower Motor.
	9. Loose wire connection between the 0-10V signal from I/O box to the	10. Measure voltage at the I/O box 0-10V output. A voltage of 8.2V equates to a 100% open valve position.
	Blower input. 10. Defective I/O Box.	11. Check the <i>Analog Out</i> option on the C-More Configuration Menu. <i>Valve Position 0-10V</i> should be selected.
	11. Wrong 0-10V output selection on the control box.	12. Check Air/Fuel Valve position at 0%, 50% and 100% open positions. The positions on the VALVE POSITION bargraph should match the readings on the Air/Fuel Valve dial.
	12. Defective Air-Fuel Valve potentiometer.13. Hard light.	13. Check igniter-injector for soot or erosion of electrode. Check injector solenoid valve to insure proper open/close operation.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Blower not running or running too slow.	Start the unit. If the blower does not run check the blower solid state relay for input and output voltage. If the relay is OK, check the blower.
	2. Defective Blocked Inlet switch.	 Start the unit. If the blower runs, turn off unit and check the Blocked Inlet switch for continuity. Replace the switch if continuity does not exist.
AIDELOW FALLET	3. Blockage in air filter or Blocked Inlet switch.	3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage. Clean or replace as necessary.
AIRFLOW FAULT DURING PURGE	Blocked blower inlet or inlet ductwork.	4. Inspect the inlet to the combustion blower including any ductwork leading up to the combustion blower for signs of blockage.
	5. No voltage to Blocked Inlet switch from C-More Control Box.	5. During the start sequence, verify that 24 VAC is present between each side of the switch and ground. If 24 VAC is not present, refer fault to qualified service personnel.
	6. PROBABLE CAUSES from 3 to 12 for AIRFLOW FAULT DURING IGNITION apply for this fault.	6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW FAULT DURING IGNITION.
	Blower stopped running due to thermal or current overload. Blocked Blower inlet or inlet	Check combustion blower for signs of excessive heat or high current draw that may trip thermal or current overload devices.
AIRFLOW FAULT DURING RUN	ductwork.	2. Inspect the inlet to the combustion blower, including any ductwork leading up to the combustion blower, for signs of blockage.
	3. Blockage in air filter or Blocked Inlet switch.	3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.
	4. Defective Blocked Inlet switch.5. Combustion oscillations.	4. Verify that 24 VAC is present between each side of the switch and ground. If 24 VAC is not present at both sides, replace switch,
	6. PROBABLE CAUSES from 3 to 16 for AIRFLOW FAULT DURING	5. Run unit to full fire. If the unit rumbles or runs rough, perform combustion calibration.6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW
	IGNITION applies for this fault.	FAULT DURING IGNITION.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Delayed Interlock Jumper not properly installed or missing.	Check to insure jumper is properly installed across the delayed interlock terminals in the I/O Box.
DELAYED INTERLOCK OPEN	Device proving switch hooked to interlocks is not closed	2. If there are 2 external wires on these terminals, check to see if an end switch for a proving device (such as a pump, louver, etc.) is tied these interlocks. Ensure that the device and/or its end switch is functional. A jumper may be temporarily installed to test the interlock.
DIRECT DRIVE	1. Direct drive signal is not present:Not yet installedWrong polaritySignal defective at sourceBroken or loose wiring.	1. Check I/O Box to ensure signal is hooked up. Hook up if not installed. If installed, check polarity. Measure signal level. Check wiring continuity between source and unit.
SIGNAL FAULT	2. Signal is not isolated (floating).	2. Check signal at source to ensure it is isolated.
	 Control Box signal type selection switches not set for correct signal type (voltage or current). 	 Check DIP switch on PMC board to ensure it is set correctly for the type of signal being sent. Check control signal type set in Configuration Menu.
	1. Worn Flame Detector.	Remove and inspect the Flame Detector for signs of wear. Replace if necessary.
	2. No spark from Spark Igniter.	Close the internal gas valve in the unit. Install and arc a spark igniter outside the unit.
FLAME LOSS DURING IGN	3. Defective Ignition Transformer.	3. If there is no spark, check for 120VAC at the primary side to the ignition transformer during the ignition cycle.
	Defective Ignition/Stepper (IGST) Board.	4. If 120VAC is not present, the IGST Board in the Control Box may be defective. Refer fault to qualified service personnel.
	5. Defective SSOV.	5. While externally arcing the spark igniter, observe the open/close indicator in the Safety Shut-Off Valve to ensure it is opening. If the valve does not open, check for 120VAC at the valve input terminals. If 120VAC is not present, the IGST board in the Control Box may be defective. Refer fault to qualified service personnel.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
FLAME LOSS	6. Carbon or other debris on Burner.	6. Remove View-Port and inspect Burner with Boroscope. If it is fouled or black with soot, remove the Burner and inspect for any carbon build-up or debris. Clean and reinstall.
DURING IGN (continued)	7. Staged ignition solenoid valve doesn't open.	7. When unit goes to ignition, listen for a clicking sound at the staged ignition solenoid valve to ensure it is opening.
	8. Clogged staged ignition piece.	8. Remove and inspect the igniter-injector and inspect the gas injector for blockage.
	Worn Flame Detector or cracked ceramic.	Remove and inspect the Flame Detector for signs of wear or cracked ceramic. Replace if necessary.
FLAME LOSS	2. Defective Regulator.	Check gas pressure readings using a gauge or manometer into and out of the Air/Fuel Valve to ensure that the gas pressure into and out of the valve is correct.
DURING RUN	3. Poor combustion calibration.	Check combustion calibration using procedures in Chapter 4.
	4. Debris on burner.	4. Remove the burner and inspect for any carbon build-up or debris. Clean and reinstall.
	5. Blocked condensate drain.	5. Remove blockage in condensate drain.
HEAT DEMAND FAILURE	The Heat Demand Relays on the Ignition/Stepper (IGST) board failed to activate when commanded.	Press CLEAR button and restart the unit. If the fault persists, replace Ignition/Stepper (IGST) Board.
	Relay is activated when not in Demand.	2. Defective relay. Replace IGST Board.
HIGH EXHAUST	Poor combustion calibration.	Check combustion calibration using procedures in Chapter 4.
TEMPERATURE	Carboned heat exchanger due to incorrect combustion calibration	2. If exhaust temperature is greater than 200° F, check combustion calibration. Calibrate or repair as necessary.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Incorrect supply gas pressure.	Check to ensure gas pressure at inlet of SSOV does not exceed 14" W.C.
HIGH GAS PRESSURE	2. Defective SSOV Actuator.	2. If gas supply pressure downstream of SSOV Actuator cannot be lowered to the range of 2.0" ± 0.4" W.C. using the gas pressure adjustment screw (see section 4.3, step 10), the SSOV Actuator may be defective.
	3. Defective High Gas Pressure Switch.	3. Remove the leads from the High Gas Pressure switch. Measure continuity across the common (C) and normally closed (NC) terminals with the unit not firing. Replace the switch if continuity does not exist.
	Faulty Water temperature switch.	Test the temperature switch to insure it trips at its actual water temperature setting.
	2. Incorrect PID settings.	2. Check PID settings against Menu Default settings in Appendix E. If the settings have been changed, record the current readings then reset them to the default values.
HIGH WATER TEMP SWITCH OPEN	3. Faulty shell temperature sensor.	3. Using the resistance charts in the Appendix C, Measure the resistance of Shell sensor and BTU sensor at a known water temperature.
SWITCH OPEN	4. Unit in Manual mode	4. If unit is in Manual Mode switch to Auto Mode.
	5. Unit setpoint is greater than Over Temperature Switch setpoint.	5. Check setpoint of unit and setpoint of Temperature Switch; Ensure that the temperature switch is set higher than the unit's setpoint.
	System flow rate changes are occurring faster than units can respond.	6. If the system is a variable flow system, monitor system flow changes to ensure that the rate of flow change is not faster than what the units can respond to.
HIGH WATER	1. See HIGH WATER TEMPERATURE SWITCH OPEN.	1. See HIGH WATER TEMPERATURE SWITCH OPEN.
TEMPERATURE	2. Temp HI Limit setting is too low.	2. Check Temp HI Limit setting.
IGN BOARD COMM FAULT	Communication fault has occurred between the PMC board and Ignition/Stepper (IGST) board	Press CLEAR button and restart unit. If fault persists, contact qualified Service Personnel.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Air/Fuel Valve not rotating Defective or shorted switch	Start the unit. The Air/Fuel Valve should rotate to the purge (open) position. If the valve does not rotate at all or does not rotate fully open, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air-Fuel Valve or the Control Box. Refer to qualified service personnel
IGN SWTCH CLOSED DURING PURGE	Switch wired incorrectly	2. If the Air/Fuel Valve does rotate to purge, check the ignition switch for continuity between the N.O. and COM terminals. If the switch shows continuity when not in contact with the cam replace the switch.
	Defective Power Supply Board	3. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals). If the switch is wired correctly, replace the switch
	or fuse 5. Defective IGST Board	4. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
		5. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board
IGN SWTCH OPEN	 Air/Fuel Valve not rotating to ignition position. Defective ignition switch 	1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position, then back to ignition position (towards closed) during the ignition cycle. If the valve does not rotate back to the ignition position, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air/Fuel Valve or the Control Box. Refer fault to qualified service personnel.
DURING IGNITION	Defective Ignition Switch 3. Defective Power Supply Board	2. If the Air/Fuel Valve does rotate to the ignition position, check the ignition position switch for continuity between the N.O. and COM terminals when in contact with the cam.
	or fuse 4. Defective IGST Board	3. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
		Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Interlock jumper not installed or removed	Check for a jumper properly installed across the interlock terminals in the I/O box.
INTERLOCK OPEN	Energy Management System does not have unit enabled.	If there are two external wires on these terminals check any Energy Management system to see if they have the units disabled (a jumper may be temporarily installed to see if the interlock circuit is functioning).
	Device proving switch hooked to interlocks is not closed.	3. Check that proving switch for any device hooked to the interlock circuit is closing and that the device is operational.
LINE VOLTAGE	Line and Neutral switched in AC Power Box.	Check hot and neutral in AC Power Box to ensure they are not reversed
OUT OF PHASE	Incorrect power supply transformer wiring.	Check transformer wiring, in AC Power Box, against the power box transformer wiring diagram to ensure it is wired correctly
LOW GAS PRESSURE	Incorrect supply gas pressure.	1. Measure gas pressure upstream of the SSOV Actuator(s) with the unit firing. For FM gas trains, ensure it is between 4.0" W.C. and 14" W.C. For IRI gas trains, ensure it is between 4.2" W.C. and 14" W.C. (see section. 2.8.1).
	Defective Low Pressure Gas Switch	2. Measure gas pressure at the Low Gas Pressure switch. If it is greater than 2.6" W.C., measure continuity across the switch and replace if necessary.
LOW WATER	Insufficient water level in system Defective water level circuitry.	 Check system for sufficient water level. Test water level circuitry using the Control Box front panel LOW WATER TEST and RESET buttons. Replace water level circuitry if it does not respond.
	3. Defective water level probe.	3. Check continuity of probe end to the shell, change probe if there is no continuity.
MODBUS COMMFAULT Unit not seeing information from Modbus network		Check network connections. If fault persists, contact qualified Service Personnel.
PRG SWTCH CLOSED DURING IGNITION	A/F Valve rotated open to purge and did not rotate to ignition position.	Start the unit. The Air/Fuel Valve should rotate to the purge (open) position, then back to ignition position (towards closed) during the ignition cycle. If the valve does not rotate back to the ignition position, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air/Fuel Valve or the Control Box. Refer fault to qualified service personnel.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
PRG SWTCH CLOSED DURING IGNITION (continued)	 Defective or shorted switch. Switch wired incorrectly. Defective Power Supply Board or fuse Defective IGST Board 	 If the Air/Fuel Valve does rotate to the ignition position, check the purge switch for continuity between the N.O. and COM terminals. If the switch shows continuity when not in contact with the cam, check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals). If the switch is wired correctly, replace the switch. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
PRG SWTCH OPEN DURING PURGE	 Defective purge switch. No voltage present at switch. Switch wired incorrectly. Defective Power Supply Board or fuse Defective IGST Board 	 If the air-fuel valve does rotate, check purge switch for continuity when closing. Replace switch if continuity does not exist. Measure for 24 VAC from each side of the switch to ground. If 24VAC is not present, refer fault to qualified service personnel. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals). Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
OUTDOOR TEMP SENSOR FAULT	 Loose or broken wiring. Defective Sensor. Incorrect Sensor. 	 Inspect Outdoor Temperature sensor for loose or broken wiring. Check resistance of sensor to determine if it is within specification. Ensure that the correct sensor is installed.
O2 % OUT OF RANGE	 Combustion Calibration incorrect. Blocked inlet air duct or louver. 	 Check Combustion Analyzer and recalibrate Boiler. Unblock air inlet and measure open area for combustion air to the room.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
RECIRC PUMP FAILURE	1. Internal recirculation pump failed.	Replace recirculation pump.
REMOTE SETPT SIGNAL FAULT	Remote setpoint signal not present: Not yet installed. Wrong polarity. Signal defective at source. Broken or loose wiring.	Check I/O Box to ensure signal is hooked up. Hook up if not installed. If installed, check polarity. Measure signal level. Check continuity of wiring between source and unit.
OIOIWAET AGET	2. Signal is not isolated (floating) if 4 to 20 mA.3. Control Box signal type selection switches not set for correct signal type (voltage or current).	 Check signal at source to ensure it is isolated. Check DIP switch on PMC board to ensure it is set correctly for the type of signal being sent. Check control signal type set in Configuration Menu.
	Defective Flame Detector.	Replace Flame Detector.
RESIDUAL FLAME	2. SSOV not fully closed.	2. Check open/close indicator window of Safety Shut-Off Valve (SSOV) and ensure that the SSOV is fully closed. If not fully closed, replace the valve and or actuator. Close the 1" Gas Shut-Off Valve downstream of SSOV (Figure 6-1). Install a manometer or gauge at the leak detection port between the SSOV and Gas Shut Off Valve. If a gas pressure reading is observed replace the SSOV Valve and/or Actuator.
SSOV FAULT DURING PURGE	See SSOV SWITCH OPEN	
SSOV FAULT DURING RUN	SSOV switch closed for 15 seconds during run.	Replace or adjust micro-switch in SSOV actuator. If fault persists, replace actuator.
	1. SSOV relay failed on IGST board.	Press CLEAR button and restart unit. If fault persists, replace Ignition/Stepper (IGST) Board.
SSOV RELAY FAILURE	2. Floating Neutral.	2. The Neutral and Earth Ground are not connected at the source and therefore there is a voltage measured between the two. Normally this measurement should be near zero or no more than a few millivolts.
	3. Hot and Neutral reversed at SSOV.	3. Check SSOV power wiring.

TABLE 8-1. BOILER TROUBLESHOOTING - Continued

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
	Actuator not allowing for full closure of gas valve	Observe operation of the Safety Shut-Off Valve (SSOV) through indicator on the Valve actuator and ensure that the valve is fully and not partially closing.
SSOV SWITCH OPEN	SSOV powered when it should not be	2. If the SSOV never closes, it may be powered continuously. Close the gas supply and remove power from the unit. Refer fault to qualified service personnel.
SWITCH OF EN	3. Defective Switch or Actuator	3. Remove the electrical cover from the SSOV and check switch continuity. If the switch does not show continuity with the gas valve closed, either adjust or replace the switch or actuator.
	4. Incorrectly wired switch.	4. Ensure that the SSOV Proof of Closure switch is correctly wired.
	Air/Fuel Valve out of calibration.	1. Refer to GF-112 (C-More O & M) and perform the Stepper Feedback Calibration procedure in Section 6, section 6.2.1.
	2. Air/Fuel Valve unplugged.	2. Check that the Air/Fuel Valve is connected to the Control Box.
STEPPER MOTOR	Loose wiring connection to the stepper motor.	3Inspect for loose connections between the Air/Fuel Valve motor and the wiring harness.
FAILURE	Defective Air/Fuel Valve stepper motor.	4. Replace stepper motor.
	5. Defective Power Supply Board or fuse	5. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
	6. Defective IGST Board	6. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.

CHAPTER 8 - TROUBLESHOOTING GUIDE

8.2 ADDITIONAL FAULTS WITHOUT SPECIFIC FAULT MESSAGES

Refer to Table 8-2 to troubleshoot faults which may occur without a specific fault message being displayed.

Table 8-2 WATER HEATER TROUBLESHOOTING WITH NO FAULT MESSAGE DISPLAYED

OBSERVED INCIDENT	PROBABLE CAUSES	CORRECTIVE ACTION
Hard Light-Off	 Staged Ignition Ball Valve closed. Clogged/damaged Gas Injector on Igniter-Injector (Figure 8-2). Defective Staged Ignition Solenoid (Figure 8-1). 	 Open the Staged Ignition Ball Valve on the upstream side of the SSOV (Figure 8-1). Disconnect the Staged Ignition Assembly solenoid from the Gas injector Tube of the Igniter-Injector (Figure 8-2) and inspect Gas Injector to ensure it is not clogged or damaged. Close the Manual Shutoff Valve (Figure 8-1, below). Attempt to start the unit and listen for a "clicking" sound that the Staged Ignition Solenoid makes during Ignition Trial. If "clicking" sound is not heard after 2 or 3 attempts, replace the Staged Ignition Solenoid.
Fluctuating Gas Pressure	Gas pressure going into unit is fluctuating. Damping Orifice not installed.	 Stabilize gas pressure going into unit. If necessary, troubleshoot Building Supply Regulator. Check to ensure that the Damping Orifice is installed in the SSOV Actuator shown in Figure 8-3. (For IRI (DBB) Gas Trains, the Damping Orifice is installed in the downstream SSOV Actuator).
Air/Fuel Valve "hunting" at the 80% Valve Position	IGST and Power Supply Boards in Control Box are outdated.	Check to ensure that the IGST and Power Supply Boards are Rev. E or higher.

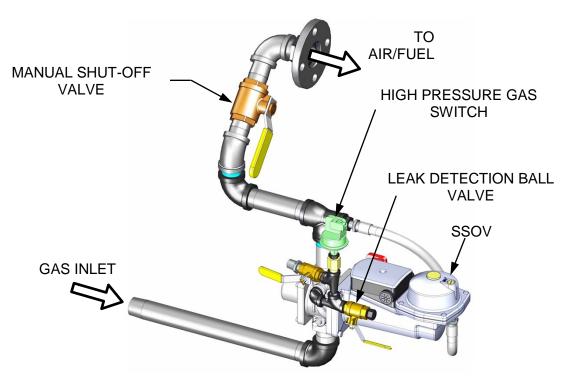


Figure 8-1: Gas Train Component Locations

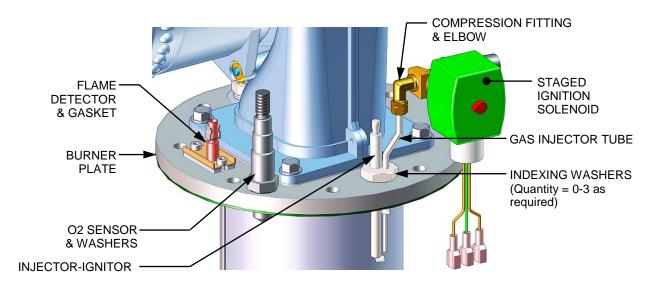


Figure 8-2: Staged Ignition Connection to Gas Injector Tube

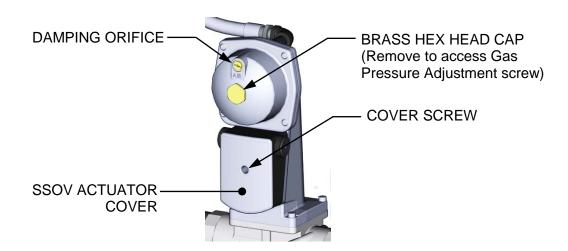


Figure 8-3: SSOV Actuator With Gas Pressure Adjustment & Damping Orifice

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual CHAPTER 8 – TROUBLESHOOTING GUIDE (This Page Is Intentionally Blank)

CHAPTER 9. RS-232 COMMUNICATION

9.1 INTRODUCTION

The RS-232 communication feature permits viewing or changing of Control Panel menu options and also provides access to data logs showing Event Time Line, Fault and Sensor log displays.

NOTE

The information in this chapter does not apply when implementing BST.

The RS-232 port on the front panel of the C-More Control Box (Figure 3-1) can be interfaced to a laptop computer or other suitable terminal using a RS-232 adapter cable. RS-232 communication can be accomplished using any "Dumb Terminal" emulation, such as "PuTTY" which is not included with Microsoft Windows, but can be downloaded for free on the internet. Source and instructions for using Putty are provided below.

9.1.1 Aquiring the PuTTY Application

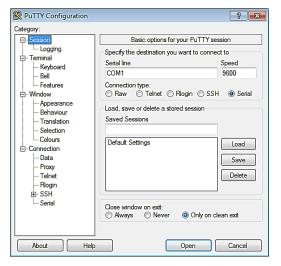
Download the **putty.exe** program to your desktop from:

www.chiark.greenend.org.uk/~sgtatham/putty/download.html

You can use PuTTY to logon to remote computers as well as run a single command on a remote server. PuTTY does not need to be installed, so just clicking the downloaded executable will start it.

9.1.2 Logging on to a Remote Machine Using PuTTY

To use PuTTY to logon to a remote machine, bring up the PuTTY application by double-clicking its icon. You will see the main window as shown in left image of Figure 9-1.



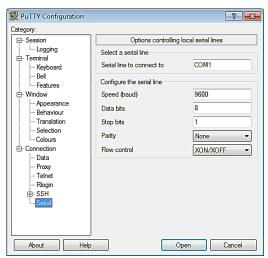


Figure 9-1: PuTTY GUI: Basic Serial Session (L) and Serial Options (R)

In Serial mode, text typed into the PuTTY window will be sent straight out of your computer's serial port, and data received through that port will be displayed in the PuTTY window.

To create a Serial connection, click the radio button labeled **Serial**. The **Serial line** and **Speed** fields will then be automatically filled in as shown in *left* image of Figure 9-1, but will allow you to specify the serial line to use (if your computer has more than one) and what speed (baud rate) to use when transferring data. For further configuration options (data bits, stop bits, parity, flow control), you can use the **Serial Configuration** panel (*right* image in Figure 9-1) by selecting "Serial" in the left navigation pane.

CHAPTER 9 - RS-232 COMMUNICATION

Now, to connect to the remote server, simply click the **Open** button at the bottom of the dialog box. A new terminal window will pop up and ask you to log in.

So that you don't have to enter this information every time you wish to connect to your server, you can save this configuration by typing an appropriate *name* in the **Saved Sessions** text box in the PuTTY "Basic Options" window (left image of Figure 9-1) and then clicking the **Save** button. In the future, you can select the *name* you chose in the list box and click the **Load** button to initialize this particular configuration.

9.1.3 Running a Command on a Remote Machine Using PuTTY

PuTTY may also be used to run some command residing on the remote server. After specifying the command line you want to run, you will be asked for your account name and password, and then the command you specified will execute. When it completes, your session will terminate, and your window will either close or remain open depending on how you configure the session. Here are the steps:

Running a Command on a Remote Machine Using PuTTY

- 1. Bring up the PuTTY application and select the server you wish to connect to.
- At the bottom of the Basic Options dialog box (left image of Figure 9-1) in the section titled: Close window on exit, select the Never radio button. This will keep the window open after the command has finished executing so that you can see any results in the terminal window.
- 3. In the menu bar along the left side of the dialog box, click the **SSH** menu near the bottom. The following screen will be presented:

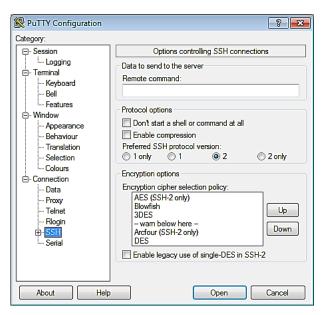


Figure 9-2: PuTTY GUI: Basic SSH Options for Running Remote Commands

- 4. Into the textbox titled, **Remote command** type the full command line you wish to have executed on the remote machine.
- 5. You are now ready to execute this command on the remote machine, simply click the **Open** button at the bottom of the dialog.
- 6. You will have to provide an account name and password in the terminal window to complete the process.

CHAPTER 9 - RS-232 COMMUNICATION

9.2 RS-232 COMMUNICATION SETUP

Regardless of the terminal emulation utilized, the following guidelines must be adhered to when setting up the RS-232 communication link:

- Baud Rate The baud rates which can be used with the C-More Control Panel are:
 - 0 2400
 - o 4800
 - o 9600 (Default)
 - o 19.2K
- Data Format The program must be set for:
 - o 8 data bits
 - o 1 stop bit
 - o no parity
 - o either Xon/Xoff or No flow control

9.3 MENU PROCESSING UTILIZING RS-232 COMMUNICATION

Viewing data logs and viewing or changing Control Panel menu options using RS-232 communication is accomplished as follows:

Menu Processing Utilizing Rs-232 Communication

- 1. Start the emulator software program and ensure that the specified baud rate and data formats have been entered.
- 2. Press the **Enter** key on the laptop. An asterisk (*) prompt should appear.
- 3. At the prompt, enter the valid RS-232 password (jaguar) in lower case letters and press Enter.
- 4. "Welcome to Aerco" will appear in the laptop or "dumb terminal" display with a listing of the following available entry choices:
 - **M** = Display next Menu
 - **D** = Display menu items
 - **N** = Display next menu items
 - Cxx = Change item xx
 - **F** = Fault log display
 - **S** = Sensor log display
 - T = Time line display
 - L = Log off

NOTE

The Level 1 password (159) must be entered to change options in the Setup, Configuration and Tuning Menus. The Level 2 password (6817) must be entered to view or change options in the Calibration and Diagnostics Menus.

With the exception of the password entry, all other keyboard entries can be made using either upper or lower case.

- 5. To view the available menus in the top-down sequence shown in Figure 3-2, enter *M* <*Rtn*>. The Menu title and first 10 options will be displayed.
- 6. When viewing menus containing more than 10 options, enter *N* <*Rtn*> to display the remaining options.

CHAPTER 9 - RS-232 COMMUNICATION

Menu Processing Utilizing Rs-232 Communication - Continued

7. Shortcut keys are also available to go directly to a specific menu. These shortcut keys are:

m0 = Default (Operating) Menu

m1 = Setup Menu

m2 = Configuration Menu

m3 = Tuning Menu m4 = Calibration Menu

- **m5** = Diagnostic Menu
- 8. To change a value or setting for a displayed menu option, proceed as follows:
 - (a) Enter **C**, followed by the number to the right of the displayed option to be changed, and then press **<***Rtn***>**.
 - (b) Enter the desired value or setting for the option and press < Rtn>. Refer to Chapter 3, Tables 3-2 through 3-5 for allowable entry ranges and settings for the Operating, Setup, Configuration and Tuning Menus. (The Calibration and Diagnostic Menus should only be used by Factory-Trained service personnel).
 - (c) Menu changes will be stored in non-volatile memory.
- To redisplay the menu and view the option which was just changed in step 5, enter D and press <*Rtn*>.
- 10. To display the Fault (F) Log, Sensor (S) Log or Time (T) Line Log, press **F**, **S** or **T** followed by **<Rtn>**. Refer to section 9.4 for descriptions and samples of these data logs.
- 11. To log off and terminate the RS-232 communication link, press L followed by <Rtn>.

9.4 DATA LOGGING

During operation, the C-More Control Panel continuously monitors and logs data associated with operational events, faults and sensor readings associated with the boiler system. Descriptions of these data logs are provided in the following sections. The basic procedure for accessing each data log is described in section 9.3 step 10.

9.4.1 Fault Log

The C-More Control Panel logs the last 20 faults (0-19) starting with the most recent (#0). They can be viewed in the front panel display or via the RS-232 port. The Fault Log cannot be cleared. If the Fault Log already contains 10 faults, the earliest fault is overwritten when a new fault occurs. A sample Fault Log display is shown in Table 9-1.

Table 9-1: Sample Fault Log Display

No.	Fault Message	Cycle	Date	Time
0	Direct Drive Signal Fault	609	1/10/02	8:42am
1	Low Gas Pressure	366	7/04/01	5:29pm
2	Loss of Power	0	1/01/01	11:50am

CHAPTER 9 - RS-232 COMMUNICATION

NOTE

The Operation Time (T) Log can store thousands of records. Therefore, to view the most recently logged record, enter "T" followed by 0 (zero) and press Enter (i.e. T0 <Enter>). To view earlier records in reverse chronological order, enter T and press Enter. To go back 200 or 1000 records, enter T200 or T1000, etc. and press Enter.

9.4.2 Operation Time Log

The Operation Time Log consists of a string of ASCII records stored in non-volatile memory within the C-More Control Panel. Events such as power-up, ignition and turn-off are time stamped. Data logged while the unit is running are run-length encoded. Data is logged or the run-length incremented every 30 seconds. For a new run record to be logged, the fire rate or flame strength must change by more than 5%, or the run mode must change. At steady-state, the run-length is allowed to reach a maximum of 30 minutes before the record is logged. This means that no more than 30 minutes of data can be lost if the unit loses power. Table 9-2 shows a sample Operation Time Log for a boiler:

The Operation Time Log can only be accessed through the RS-232 interface using a laptop or other terminal device. Ten operation time records are displayed for each T command entry. The operation time log can be cleared ONLY by factory authorized personnel using the Clear Log option in the Factory menu.

Status	Fire Rate	Flame	Run Length	Date	Time
Off, Direct Drive	0	0	8	1/15/02	2:35pm
Run, Direct Drive	38	100	34	1/15/02	2:27pm
Run, Direct Drive	31	100	30	1/15/02	1:53am
Run, Direct Drive	35	100	2	1/15/02	1:23pm
Run, Direct Drive	29	100	0	1/15/02	1:21pm
Ignition	0	0	0	1/15/02	1:20pm
Off, Switch	0	0	35	1/15/02	12:30pm
Run, Manual	40	100	0	1/15/02	11:55am
Ignition	0	0	0	1/15/02	11:55am
Power-up	0	0	0	1/15/02	11:50am

Table 9-2: Sample Operation Time Log Display

NOTE

The Sensor (S) Log can store up to 1200 records. Therefore, to view the most recently logged record, enter "S" followed by 0 (zero) and then press Enter (i.e. S0 <Enter>). To view earlier records in reverse chronological order, enter S and press Enter. To go back 200 or 700 records, enter S200 or S700, etc. and press Enter.

CHAPTER 9 - RS-232 COMMUNICATION

9.4.3 Sensor Log

The sensor values can be logged at a different rate if needed by setting the Sensor Log Interval in the Diagnostics Menu. The log interval can vary from once every minute to once every day. Table 9-3 shows a sample Sensor Log every 5 minutes for a boiler running in Constant Setpoint mode.

Table 9-3: Sample Sensor Log Display

Setpt	Outlet	Outdr	FFWD	Aux	Inlet	Exhst	СО	02	Flow	Date	Time
130	181	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:51pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:46pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:41pm
130	179	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:36pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:31pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:26pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:21pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:16pm
130	179	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:11pm
130	180	OPEN	OPEN	OPEN	OPEN	OPEN	0	.0	0	1/15/02	5:06pm

10.1 INTRODUCTION

The C-More on-board Boiler Sequencing Technology system (BST) is an integrated 8 boiler control system designed into the C-More controller. The BST has its own sophisticated PID control system designed to simultaneously control the light off and modulation of up to 8 boilers while achieving maximum operational efficiency.

BST is designed to ensure that all Boilers in the system operate at maximum efficiency. This is accomplished by lighting off boilers only if all ignited boilers reach or exceed a defined Valve Position (Fire Rate). Operating all boilers below the defined Fire Rate "Next on VP" (for Next Turn on Valve Position) insures that they are firing at their most efficient Fire Rate. One C-More unit is defined as the MASTER unit and all other C-More units on the BST Modbus Network are defined as SLAVE units. The Master unit will monitor the system Header Temperature, monitor all Slave units' status information and efficiently control all units in order to achieve and maintain the required BST Setpoint Temperature.

When there is a demand, the Master unit will light off one of the boilers based on the BST Sequencing selection in the BST menu. As system load increases and the valve position of the ignited units reach the Next On VP (% valve position), the BST master will light off the next available unit. A simplified block diagram of multiple Boilers connected to a BST is shown in Figure 9-1 below.

Modbus FFWD Header Header Sensor Sensor OUTLET Optional Actuator Note: Modbus Header sensor Controlled can be connected to any Sequencing boiler on the Modbus Network Valve Boiler Boiler Boiler #1 #2 #8 Note: FFWD Header Sensor Slave Master Slave must be connected to a Master INLET

Note: Use either FFWD Header sensor or Modbus Header Sensor.

Figure 10-1. Simplified BST Block Diagram

CHAPTER 10. BOILER SEQUENCING TECHNOLOGY

10.2 AERCO BST QUICK START CHART

Select the single option that suites your installation and then complete the instructions in the corresponding sub-sections of section 10.3 BST Implementation Instructions.

Constant Setpoint (choose option 1 or 2)

Option 1 – Direct Wired Header Complete section 10.3.1

OR

Option 2 – Modbus Header Complete section 10.3.2

Outdoor Reset (choose option 3 or 4)

Option 3 – Direct Wired Header AND Direct Wired Complete section 10.3.3

Outdoor Air

OR

Option 4 – Modbus Header AND Modbus Outdoor Air Complete section 10.3.4

Remote Setpoint (choose option 5 through 8)

Option 5 – 4-20ma Drive AND Direct Wired Header Complete section 10.3.5

OR

Option 6 – Modbus Drive AND Direct Wired Header Complete section 10.3.6

OR

Option 7 – 4-20ma Drive AND Modbus Header Complete section 10.3.7

OR

Option 8 – Modbus Drive AND Modbus Header Complete section 10.3.8

10.3 BST IMPLEMENTATION INSTRUCTION

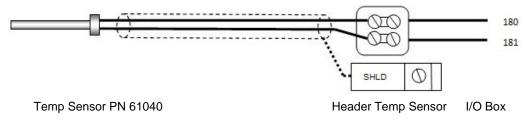
10.3.1 Option 1 - Constant Setpoint with <u>DIRECT</u> Wired Header Sensor

Step 1: Direct Wired Header Sensor Wiring

 On the MASTER Unit, Connect the Header Temperature Sensor (AERCO PN 61040) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled "Header Temp sensor" in the I/O Box.

NOTES:

- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- Shielded pair 18 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.



Step 2: Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
- 2. Go to the **BST Menu** and set the **BST Mode** item to **BST Slave** (for now).

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the desired Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select Constant **Setpoint**.
- 6. Go to the **Head Temp Source** item and select **FFWD Temp**.

When ALL C-More units have been configured:

7. Go to the **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

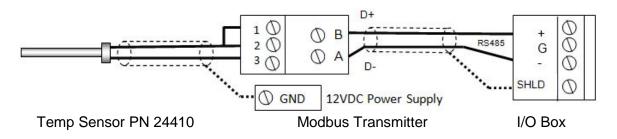
10.3.2 Option 2 - Constant Setpoint with MODBUS Wired Header Sensor

Step 1: MODbus Header Sensor Wiring

- 1. Using Shielded pair 18 22 AWG cable, connect the Temperature Transmitter (AERCO P/N 65169) terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler units.
- 2. Using Shielded pair 18 22 AWG cable, connect the Modbus Header Temperature Sensor (AERCO PN 24410) to pins 2 and 3 of the Temperature Transmitter.
- 3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

NOTES:

- Polarity must be observed for the RS485 connections.
- The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



Step 2: Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
- 2. Go to the **BST Menu** and set the **BST Mode** item to **BST Slave** (for now).

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the desired Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select Constant **Setpoint**.
- 6. Go to the **Head Temp Source** item and select **Network**.
- 7. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
- 8. Go to the **Header Temp Point** item and enter the Modbus Point (14).

When ALL C-More units have been configured:

9. Go to the **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST** MASTER.

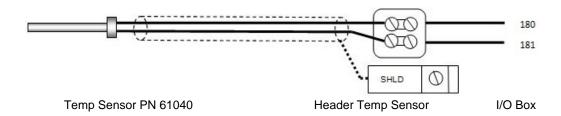
10.3.3 Option 3 - Outdoor Reset with <u>DIRECT WIRED</u> Header Sensor AND <u>DIRECT WIRED</u> Outdoor Sensor

NOTE: Both Header Sensor AND Outdoor Sensor must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1 - Direct Wired Header Sensor Wiring

 On the MASTER Unit, connect the Header Temperature Sensor (AERCO PN 61040) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled "Header Temp sensor" in the I/O Box.

NOTES: The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header. Shielded pair 18 - 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.

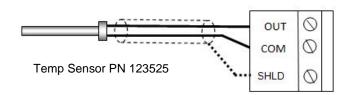


Step 2 - Direct Wired Outdoor Sensor

1. On the MASTER Unit, Connect the Outdoor Temperature Sensor (**AERCO PN 123525**) to the "OUT" and "COM" terminals in the I/O Box.

NOTES:

- Twisted shielded pair 18 22 AWG cable is recommended for header sensor wiring. There
 is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O
 the Box. The sensor end of the shield must be left free and ungrounded.
- When mounting the Outdoor sensor, it must be located on the North side of the building
 where an average outside air temperature is expected. The sensor must be shielded from
 direct sunlight as well as impingement by the elements. The outdoor sensor may be wired
 up to 200 feet from the boiler.



CHAPTER 10. BOILER SEQUENCING TECHNOLOGY

Option 3 – Continued

Step 3 - Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
- 2. Go to the **BST Menu** and set the **BST Mode** item to **BST Slave** (for now).

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select **Outdoor Reset**.
- 6. Go to the **Head Temp Source** item and select **FFWD Temp**.
- 7. Go to the **BST Outdoor Sens** item and select **Enabled**.
- 8. Go to the **Outdoor Temp Source** item and select **Outdoor Temp**.

When ALL C-More units have been configured:

9. Go to the **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

10.3.4 Option 4 - Outdoor Reset with MODBUS Header Sensor AND MODBUS Outdoor Sensor

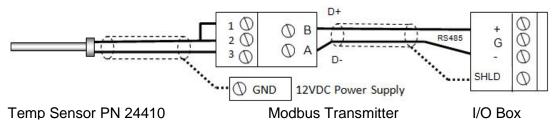
NOTE: Both Header Sensor AND Outdoor Sensor must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1 - Modbus Header Sensor Wiring

- 1. Using Shielded pair 18 22 AWG cable, connect the Temperature Transmitter (AERCO P/N 65169) terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler units.
- 2. Using Shielded pair 18 22 AWG cable, connect the Modbus Header Temperature Sensor (AERCO PN 24410) to pins 2 and 3 of the Temperature Transmitter.
- 3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

NOTES:

- Polarity must be observed for the RS485 connections. The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



Step 2 - Modbus Outdoor Sensor Wiring

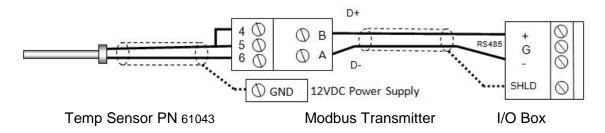
- 1. If you have not already done so when installing the Modbus Header Sensor, use Shielded pair 18 - 22 AWG cable to connect the Temperature Transmitter terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler units.
- 2. Using Shielded pair 18 22 AWG cable, connect the Modbus Header Temperature Sensor (AERCO PN 24410) to pins 2 and 3 of the Temperature Transmitter.
- 3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

NOTES:

- Polarity must be observed for the RS485 connections. The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- When mounting the Outdoor sensor, it must be located on the North side of the building where an average outside air temperature is expected. The sensor must be shielded from direct sunlight as well as impingement by the elements. The outdoor sensor may be wired up to 200 feet from the boiler.

Option 4 – Continued

• There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



Step 3 - Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu item to Enabled**.
- 2. Go to the **BST Menu** and set the **BST Mode item** to **BST Slave** (for now).

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select **Outdoor Reset**.
- 6. Go to the **Head Temp Source** item and select **Network**.
- 7. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
- 8. Go to the **Header Temp Point** item and enter the Modbus Point (14).
- 9. Go to the BST Outdoor Sens item and select Enabled.
- 10. Go to the **Outdoor Temp Source** item and select **Network**.
- 11. Go to the **Outdoor Temp Addr** item and enter the Modbus Address (240).
- 12. Go to the **Outdoor Temp Point item** and enter the Modbus Point (15).

When ALL C-More units have been configured:

13. Go to the **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

10.3.5 Option 5 - Remote Setpoint with DIRECT WIRED Header Sensor AND 4-20ma Setpoint Drive

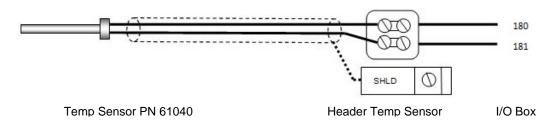
NOTE: Both Header Sensor AND 4-20ma Direct Drive must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1: Direct Wired Header Sensor Wiring

1. On the MASTER Unit, Connect the Header Temperature Sensor (AERCO PN 61040) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled "Header Temp sensor" in the I/O Box.

NOTES:

- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- Shielded pair 18 22 AWG cable is recommended for header sensor wiring.
- There is no polarity to be observed.
- The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- The sensor end of the shield must be left free and ungrounded.

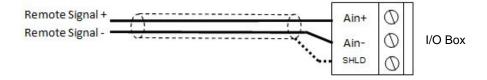


Step 2: Direct Wired 0-20ma or 4-20ma Wiring

1. Connect the 4-20ma or 0-20ma terminals from the Direct Drive source to the Ain+ and Ainterminals on the Master Unit's I/O Box.

NOTE:

- Shielded pair 18 22 AWG cable is recommended for this connection. Polarity must be observed.
- The ground for the shield is at the driver signal source.



CHAPTER 10. BOILER SEQUENCING TECHNOLOGY

Option 5 – Continued

Step 3: Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
- 2. Go to the BST Menu and set the BST Mode item to BST Slave (for now) .

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select **Remote Setpoint**.
- 6. Go to the **Head Temp Source** item and select **FFWD Temp**.
- 7. Go to the **BST Remote Signal** and select either **4-20ma** or **0-20ma**.

When ALL C-More units have been configured:

8. Go to the **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

10.3.6 Option 6 - Remote Setpoint with DIRECT WIRED Header Sensor AND **MODBUS Setpoint Drive**

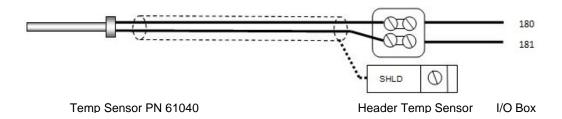
NOTE: Both Header Sensor AND the ProtoNode SSD Device must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1: Direct Wired Header Sensor Wiring

1. On the MASTER Unit, Connect the Header Temperature Sensor (AERCO PN 61040) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled "Header Temp sensor" in the I/O Box.

NOTES:

- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- Shielded pair 18 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.



Step 2: Remote Setpoint with Network

1. Configure and Connect the SSD Device (ProtoNode) per the AERCO Manual (GF129).

Step 3: Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
- 2. Go to the **BST Menu** and set the **BST Mode** item to **BST Slave** (for now).

On Master only:

- 3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select **Remote Setpoint**.
- 6. Go to the **Head Temp Source** item and select **FFWD Temp**.
- 7. Go to the **BST Remote Signal** item and select **Network**.

When ALL C-More units have been configured:

8. Go to the BST Menu of the desired Master unit and set the BST Mode item to BST MASTER.

10.3.7 Option 7 - Remote Setpoint with MODBUS Header Sensor AND 4-20ma **Setpoint Drive**

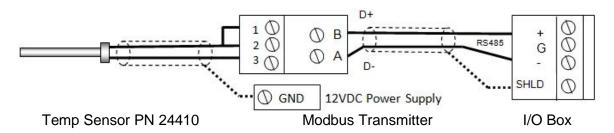
NOTE: Both Header Sensor AND 4-20ma Direct Drive must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1: MODbus Header Sensor

- 1. Using Shielded pair 18 22 AWG cable, Connect the Temperature Transmitter (AERCO P/N 65169) terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler units.
- 2. Using Shielded pair 18 22 AWG cable, connect the Modbus Header Temperature Sensor (AERCO PN 24410) to pins 2 and 3 of the Temperature Transmitter.
- 3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

NOTES:

- Polarity must be observed for the RS485 connections. The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.

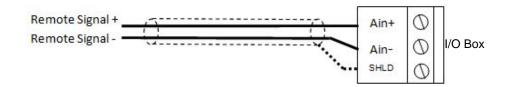


Step 2: Direct Wired 0-20ma or 4-20ma Wiring

1. Connect the 4-20ma or 0-20ma terminals from the Direct Drive source to the Ain+ and Ainterminals on the Master.

NOTES:

- Unit's I/O Box. Shielded pair 18 22 AWG cable is recommended for this connection. Polarity must be observed.
- The ground for the shield is at the driver signal source.



CHAPTER 10. BOILER SEQUENCING TECHNOLOGY

Option 7 - Continued

Step 3: Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the Configuration Menu and set the BST Menu item to Enabled.
- 2. Go to the **BST Menu** and set the **BST Mode** item to **BST Slave** (for now).

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
- 4. Go to the **BST Setup Menu** item and set to **Enabled**.
- 5. Go to the **BST Setpoint Mode** item and select Remote **Setpoint**.
- 6. Go to the BST Remote Signal and select either 4-20ma or 0-20ma.
- 7. Go to the **Head Temp Source** item and select **Network**.
- 8. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
- 9. Go to the **Header Temp Point** item and enter the Modbus Point (14).

When ALL C-More units have been configured:

 Go to the BST Menu of the desired Master unit and set the BST Mode item to BST MASTER.

OMM-0082_0J GF-130

10.3.8 Option 8 - Remote Setpoint with <u>MODBUS</u> Header Sensor AND <u>MODBUS</u> Setpoint Drive

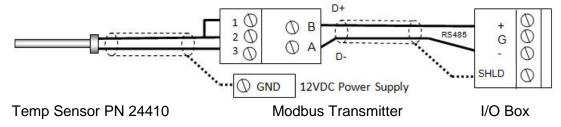
NOTE! Both Header Sensor AND ProtoNode SSD Device must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1: MODbus Header Sensor

- Using Shielded pair 18 22 AWG cable, Connect the Temperature Transmitter (AERCO P/N 65169) terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler units.
- 2. Using Shielded pair 18 22 AWG cable, connect the Modbus Header Temperature Sensor (**AERCO PN 24410**) to pins 2 and 3 of the Temperature Transmitter.
- 3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

NOTES:

- Polarity must be observed for the RS485 connections. The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



Step 2: Remote Setpoint with Network

1. Configure and Connect the SSD Device (ProtoNode) per the AERCO Manual (GF129).

CHAPTER 10. BOILER SEQUENCING TECHNOLOGY

Option 8 - Continued

Step 3: Configure ALL C-More Units

On ALL Boilers:

- 1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
- 2. Go to the **BST Menu** and set the **BST Mode** item to **BST Slave** (for now).

On MASTER only:

- 3. Go to the **BST Setpoint** item and enter the failsafe Setpoint.
- 4. Go to the BST Setup Menu item and set to Enabled.
- 5. Go to the **BST Setpoint Mode** item and select Remote **Setpoint**.
- 6. Go to the **BST Remote Signal** and select either **Network**.
- 7. Go to the **Head Temp Source** item and select **Network**.
- 8. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
- 9. Go to the **Header Temp Point** item and enter the Modbus Point (14).

When ALL C-More units have been configured:

10. Go to the **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

OMM-0082_0J GF-130

CHAPTER 10. BOILER SEQUENCING TECHNOLOGY

(This Page Is Intentionally Blank)

APPENDIX A: BOILER MENU ITEM DESCRIPTIONS

MENU LEVEL & OPTION	DESCRIPTION
(OPERATING MENU
Active Setpoint	This is the setpoint temperature to which the control is set when operating in the Constant Setpoint, Remote Setpoint or Outdoor Reset Mode. When in the Constant Setpoint Mode, this value is equal to the Internal Setpoint setting in the Configuration Menu. When in the Remote Setpoint Mode, this value is the setpoint equivalent to the remote analog signal supplied to the unit. When in the Outdoor Reset Mode, this is the derived value from the charts in Appendix D.
Inlet Water Temp	Displays the inlet water temperature in °F or °C. Default is °F
Air Temp	Air Temp is the air temperature at the input to the Air/Fuel Valve. This reading is one of the parameters used to control the Blower Motor speed.
Outdoor Temp	Outdoor temperature is displayed in °F (default) or °C only if outdoor sensor is installed and enabled.
Valve Position In	Desired input valve position. This would normally be the same as the fire valve position shown on the bargraph (valve position out) when the boiler is operating.
Exhaust Temp	Displays the exhaust temperature in °F (default), or °C.
Flame Strength	Displays flame strength from 0% to 100%.
Oxygen Level	Displays the real-time combustion oxygen (O_2) level $(%)$ measured by the O_2 sensor.
Run Cycles	Displays the total number of run cycles from 0 to 999,999.
Run Hours	Displays total run time of unit in hours from 0 to 9,999,999.
Fault Log	Displays information on the last 20 faults.

APPENDIX A – BOILER MENU ITEM DESCRIPTIONS

MENU LEVEL & OPTION	DESCRIPTION
	SETUP MENU
Password	Allows Level 1 or Level 2 password to be entered. Entering the Level 1 Password (159) allows options in the Setup, Configuration and Tuning Menus to be modified. Entering the Level 2 Password (6817) allows options in the Calibration and Diagnostics Menus to be changed or activated, in addition to all Level 1 Menu options.
Language	Permits selection of English, Spanish or French for displayed messages. Default is English.
Time	Displays time from 12:00 am to 11:59 pm.
Date	Displays dates from 01/01/00 to 12/31/99
Unit of Temp	Permits selection of temperature displays in degrees Fahrenheit (°F) or degrees Celsius (°C). Default is °F.
Comm Address	For RS-485 communications (0 to 127). Default address is 0. RS-232 should have its own (programmable) password.
Baud Rate	Allows communications Baud Rate to be set (2400 to 19.2K). Default is 9600.
Min Upload Timer	Mandatory for AERCO OnAER Remote Data Collection (ORDC). This parameter enables ORDC and defines the minimum amount of time between heartbeat data uploads in seconds. The COMM LED will light during the upload.
Unit Alpha	Mandatory for AERCO OnAER Remote Data Collection. This value must match the first alpha digit on the Code Plate, e.g., G -12-1234.
Unit Year	Mandatory for AERCO OnAER Remote Data Collection. This value must match the 2-digit year on the Code Plate, e.g., G-12-1234.
Unit Serial #	Mandatory for AERCO OnAER. Remote Data Collection. This value must match the 4-digit serial # on the Code Plate, e.g., G-12-1234.
Software Version	Identifies the current software version of the control box (Ver 0.0 to Ver 9.9).
Internal Setpoint	Allows internal setpoint to be set. Default is 130°F.
Unit Type	Allows selection of KC Boiler, KC Boiler LN, BMK Boiler Std, BMK BIr Std Dual, BMK Boiler LN, BMK BIr LN Dual, KC Water Heater, KC Wtr Heater LN, Innovation WH

APPENDIX A - BOILER MENU ITEM DESCRIPTIONS

MENU LEVEL & OPTION	DESCRIPTION
CC	ONFIGURATION MENU
Internal Setpoint	Allows internal setpoint to be set (40°F to 240°F). Default is 130°F.
Unit Size	Sets unit size from 600 MBH to 6000 MBH depending on the Unit Type.
Fuel Type	Allows selection of Natural Gas or Propane
Boiler Mode (If Unit Type = Boiler)	It allows selection of: Constant Setpoint, Remote Setpoint, Direct Drive, Combination, or Outdoor Reset Mode. Default is Constant Setpoint Mode.
Remote Signal (If Mode = Remote Setpoint, Direct Drive or Combination)	Used to set the type of external signal which will be used when operating in the Remote Setpoint, Direct Drive or Combination Mode. The factory default is 4-20 mA/1-5V.
Bldg Ref Temp (If Boiler Mode = Outdoor Reset)	Allows the building reference temperature to be set when operating a boiler in the Outdoor Reset Mode. Default is 70°F.
Reset Ratio (If Boiler Mode = Outdoor Reset)	Permits setting of Reset Ratio when operating boiler in the Outdoor Reset Mode. Reset Ratio is adjustable from 0.1 to 9.9. Default is 1.2.
Outdoor Sensor	Allows outdoor sensor function to be enabled or disabled. Default is disabled.
System Start Tmp (If Outdoor Sensor is Enabled)	If outdoor sensor is enabled, this menu item allows the system start temperature to be set from 30 to 100°F. Default is 60°F.
Setpoint Lo Limit	Used to set the minimum allowable setpoint (40°F to Setpoint Hi Limit). Default is 60°F
Setpoint Hi Limit	Used to set the maximum allowable setpoint (Setpoint Lo Limit to 210°F). Default is 140°F.
Temp Hi Limit	This is the maximum allowable outlet temperature (40 to 210°F). Any temperature above this setting will turn off the unit. The temperature must then drop 5° below this setting to allow the unit to run. Default Hi Limit is 160°F.
Max Valve Position	Sets the maximum allowable valve position for the unit (40% to 100%). Default is 100%.
Pump Delay Timer	Specifies the amount of time (0 to 30 min.) to keep the pump running after the unit turns off. Default is zero.

APPENDIX A – BOILER MENU ITEM DESCRIPTIONS

MENU LEVEL & OPTION	DESCRIPTION		
CONFI	GURATION MENU (Cont.)		
Aux Start On Dly	Specifies the amount of time to wait (0 to 120 sec.) between activating the Aux Relay (due to a demand) and checking the pre-purge string to start the boiler. Default is 0 sec.		
Failsafe Mode	Allows the Failsafe mode to be set to either Constant Setpoint or Shutdown. Default is Shutdown.		
Analog Output	Must be set to Valve Pos 0-10V for BMK 750 & 1000.		
Lo Fire Timer	Specifies how long (2 to 600 sec.) to remain in the low fire position after ignition, before going to the desired output. Default is 2 sec.		
Setpt Limiting	Setpoint Limiting can be Enables or Disablled. The default setting is Enabled.		
Setpt Limit Band	The Setpoint Limit Band can be set from 0 to 10. The default setting is 5.		
Network Timeout	Specifies the timeout value (seconds) before a Modbus fault is declared. Available settings range from 5 to 999 seconds. Default is 30 seconds.		
Shutoff Dly Temp	This feature delays the shutdown of a boiler in order to reduce excessive cycling. This specifies the temperature value the Outlet Temperature is permitted to rise above setpoint before being shut down. Span is 0 to 25, Default is 10.		
Demand Offset	This entry will reduce excessive ON/OFF cycling in AUTO mode. When this entry is a non-zero value, the unit will not turn on again until <i>Valve Position In</i> reaches the Start Level value AND the Outlet Temperature goes below the <i>Active Setpoint – Demand Offset</i> . In addition, the boiler will fire at the 29% Valve Position level or below for a period of one minute. When this entry is set to zero, the unit will turn on again as soon as the <i>Valve Position in</i> reaches the <i>Start Level</i> value. There will not be a one minute delay when firing at the 29% Valve Position level.		
	Setting range is 0 to 25. (Default is 10)		

APPENDIX A - BOILER MENU ITEM DESCRIPTIONS

MENU LEVEL & OPTION	DESCRIPTION	
CONFIGURATION MENU (Cont.)		
Deadband High Deadband Low	Deadband High and Deadband Low settings create an "Outlet Temperature" Zone in which no Valve Position corrections will be attempted.	
	The Deadband ZONE is defined as operating with an Outlet Temperature between Active Setpoint + Deadband High and Active Setpoint – Deadband Low.	
	When the Outlet Temperature reaches Active Setpoint and remains there for a period of 15 seconds, the unit will go into a DEADBAND MODE at which point no Valve Position corrections will be attempted while the Outlet Temperature remains anywhere within the Deadband ZONE. When the unit is in the DEADBAND MODE, the °F or °C LED will flash on and off. When the Outlet Temperature drifts out of the Deadband ZONE, the DEADBAND MODE will be terminated and the PID LOOP will again attempt Valve Position corrections.	
	Setting range is 0 to 25. (Default is 2 for both Deadband High and Deadband Low)	
IGST Version	Displays the version of the IGST Board installed.	
IGN Time Setting	Displays the MAX Ignition time of 4 Seconds or 7 Seconds as set in the Safety String Harness.	
Slow Shutdown	Enables or Disables the slow shutdown feature. Default is Disabled.	
Slow Sht Duration	With the Slow Shutdown feature Enabled, sets the time a boiler will continue to run at the Stop Level after running above the Slow Sht Threshold level for 60 Seconds. Span is 0 to 9999 Seconds, Default is 60 Seconds.	
Slow Sht Threshold	Sets the Fire Rate above which a boiler will trigger the Slow Shutdown feature. Span is 40% to 100%, Default is 60%.	

APPENDIX A – BOILER MENU ITEM DESCRIPTIONS

TUNING MENU	DE	DESCRIPTION	
Prop Band	between the setpoint tentemperature. If the actual proportional band setting less than 100%. If the e	Generates a fire rate based on the error that exists between the setpoint temperature and the actual outlet temperature. If the actual error is less than the proportional band setting (1 to 120°F), the fire rate will be less than 100%. If the error is equal to or greater than the proportional band setting, the fire rate will be 100%.	
Integral Gain	This sets the fraction of the output, due to setpoint error, to add or subtract from the output each minute to move towards the setpoint. Gain is adjustable from 0.00 to 1.00 (Default is 1.0).		
Derivative Time	change of the setpoint e	This value (0.0 to 2.0 min.) responds to the rate of change of the setpoint error. This is the time that this action advances the output.	
WARMUP	The feature embodied in the next three menu items eliminates Temperature Overshoots during the "Warmup" period of a cold ignition cycle on all boilers by temporarily modifying the PID Gain parameter during warmup and for a period defined in the Tuning Menu.		
Warmup Prop Band	Range = 1-120	Default = 95	
Warmup Int Gain	Range = 1-200	Default = 50	
Warmup PID Timer	Range = 1-240	Default = 20	
Reset Defaults?	Allows Tuning Menu opt Default values.	Allows Tuning Menu options to be reset to their Factory Default values.	

APPENDIX B: STARTUP, STATUS & DISPLAY MESSAGES

Table B-1: Startup and Status Messages

MESSAGE	DESCRIPTION
DEMAND DELAY XX sec	Displayed if Demand Delay is active.
DISABLED HH:MM pm, pm MM/DD/YY	Displayed if ON/OFF switch is set to OFF. The display also shows the time (am or pm) and date that the unit was disabled.
FLAME PROVEN	Displayed after flame has been detected for a period of 2 seconds. Initially, the flame strength is shown in %. After 5 seconds has elapsed, the time and date are shown in place of flame strength.
IGNITION TRIAL XX sec	Displayed during ignition trial of startup sequence. The duration of cycle counts up in seconds.
PURGING XX sec	Displayed during the purge cycle during startup. The duration of the purge cycle counts up in seconds.
STANDBY	Displayed when ON/OFF switch is in the ON position, but there is no demand for heat. The time and date are also displayed.
WAIT	Prompts the operator to wait.
WARMUP XX sec	Displayed for 2 minutes during the initial warm-up only.

APPENDIX B – STARTUP, STATUS & DISPLAY MESSAGES

Table B-2: Fault Messages

FAULT MESSAGE	FAULT DESCRIPTION			
AIRFLOW FAULT DURING PURGE	The Blower Proof Switch opened during purge, or air inlet is blocked.			
AIRFLOW FAULT DURING IGN	The Blower Proof Switch opened during ignition.			
AIRFLOW FAULT DURING RUN	The Blower Proof Switch opened during run.			
DELAYED INTERLOCK OPEN	The Delayed Interlock is open.			
DIRECT DRIVE SIGNAL FAULT	The direct drive signal is not present or is out of range.			
FFWD TEMP SENSOR FAULT	The temperature measured by the Feed Forward (FFWD) Sensor is out of range.			
FLAME LOSS DURING IGN	The Flame signal was not seen during ignition or lost within 5 seconds after ignition.			
FLAME LOSS DURING RUN	The Flame signal was lost during run.			
HEAT DEMAND FAILURE	The Heat Demand Relays on the Ignition board failed to activate when commanded.			
HIGH EXHAUST TEMPERATURE	The Exhaust Temperature has exceeded 200°F.			
GAS PRESSURE FAULT	The High Gas Pressure Switch OR Low Gas Pressure Switch is open.			
HIGH WATER TEMPERATURE	The temperature measured by the Outlet Sensor exceeded the Temp Hi Limit setting.			
HIGH WATER TEMP SWITCH OPEN	The High Water Temperature Limit Switch is open.			
IGN BOARD COMM FAULT	A communication fault has occurred between the PMC board and Ignition board.			
IGN SWTCH CLOSED DURING PURGE	The Ignition Position Limit switch on the Air/Fuel Valve closed during purge.			
IGN SWTCH OPEN DURING IGNITION	The Ignition Position Limit switch on the Air/Fuel Valve opened during ignition.			
INTERLOCK OPEN	The Remote Interlock is open.			
LINE VOLTAGE OUT OF PHASE	The Line (Hot) and Neutral wires are reversed.			
LOW WATER LEVEL	The Low Water Cutoff board is indicating low water level.			
NETWORK COMM FAULT	The RS-485 network information is not present or is corrupted.			
O ₂ % OUT OF RANGE	The O ₂ % has gone below 3% or above 8%.			

APPENDIX B - STARTUP, STATUS & DISPLAY MESSAGES

Table B-2: Fault Messages - Continued

FAULT MESSAGE	FAULT DESCRIPTION
OUTDOOR TEMP SENSOR FAULT	The temperature measured by the Outdoor Air Sensor is out of range.
OUTLET TEMP SENSOR FAULT	 The temperature measured by the Outlet Sensor is out of range: OUTLET TEMPERATURE display = SHt Indicates sensor is shorted OUTLET TEMPERATURE display = Opn indicates sensor
PRG SWTCH CLOSED DURING IGNITION	is open-circuited The Purge Position Limit Switch on the Air/Fuel Valve closed during ignition.
PRG SWTCH OPEN DURING PURGE	The Purge Position Limit Switch on the Air/Fuel Valve opened during purge.
REMOTE SETPT SIGNAL FAULT	The Remote Setpoint signal is not present or is out of range.
RESIDUAL FLAME	The Flame signal was seen for more than 60 seconds during standby.
SSOV SWITCH OPEN	The SSOV switch opened during standby.
SSOV FAULT DURING PURGE	The SSOV switch opened during purge.
SSOV FAULT DURING IGN	The SSOV switch closed or failed to open during ignition.
SSOV FAULT DURING RUN	The SSOV switch closed for more than 15 seconds during run.
SSOV RELAY FAILURE	A failure has been detected in one of the relays that control the SSOV.
STEPPER MOTOR FAILURE	The Stepper Motor failed to move the Air/Fuel Valve to the desired position.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual APPENDIX B - STARTUP, STATUS & DISPLAY MESSAGES (This Page Is Intentionally Blank)

APPENDIX C: SENSOR RESISTANCE/VOLTAGE CHART

Temperature Sensor Resistance Voltage Chart (Balco)

TEMP (°F)	RES (OHMS)	VOLTS*
-40	779.0	1.93
-30	797.5	1.96
-20	816.3	1.99
-10	835.4	2.02
0	854.8	2.05
10	874.6	2.07
20	894.7	2.10
30	915.1	2.12
40	935.9	2.15
50	956.9	2.17
60	978.3	2.20
70	1000.0	2.23
80	1022.0	2.25
90	1044.4	2.27
100	1067.0	2.30
110	1090.0	2.32
120	1113.3	2.34
130	1137.0	2.36
140	1160.9	2.39
150	1185.2	2.41
160	1209.5	2.43
170	1234.7	2.45
180	1260.0	2.47
190	1285.6	2.50
200	1311.4	2.52
210	1337.7	2.54
220	1364.2	2.56
230	1391.0	2.58
240	1418.2	
250	1445.7	

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual APPENDIX C – SENSOR RESISTTANCE/VOLTAGE CHART (This Page Is Intentionally Blank)

APPENDIX D - INDOOR/OUTDOOR RESET RATIO CHARTS

Table D-1. Header Temperature for a Building Reference Temperature of 50F

		RESET RATIO								
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
50F	50	50	50	50	50	50	50	50	50	50
45F	53	54	55	56	57	58	59	60	60	62
40F	56	58	60	62	64	66	68	70	72	74
35F	59	62	65	68	71	74	77	80	83	86
30F	62	66	70	74	78	82	86	90	94	98
25F	65	70	75	80	85	90	95	100	105	110
20F	68	74	80	86	92	98	104	110	116	122
15F	71	78	85	92	99	106	113	120	127	134
10F	74	82	90	98	106	114	122	130	138	146
5F	77	86	95	104	113	122	131	140	149	158
0F	80	90	100	110	120	130	140	150	160	170
-5F	83	94	105	116	127	138	149	160	171	182
-10F	86	98	110	122	134	146	158	170	182	194
-15F	89	102	115	128	141	154	167	180	193	206
-20F	92	106	120	134	148	162	176	190	204	218

Table D-2. Header Temperature for a Building Reference Temperature of 60F

					RESET	RATIO				
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
60F	60	60	60	60	60	60	60	60	60	60
55F	63	64	65	66	67	68	69	70	71	72
50F	66	68	70	72	74	76	78	80	82	84
45F	69	72	75	78	81	84	87	90	93	96
40F	72	76	80	84	88	92	96	100	104	108
35F	75	80	85	90	95	100	105	110	115	120
30F	78	84	90	96	102	108	114	120	126	132
25F	81	88	95	102	109	116	123	130	137	144
20F	84	92	100	108	116	124	132	140	148	156
15F	87	96	105	114	123	132	141	150	159	168
10F	90	100	110	120	130	140	150	160	170	180
5F	93	104	115	126	137	148	159	170	181	192
0F	96	108	120	132	144	156	168	180	192	204
-5F	99	112	125	138	151	164	177	190	203	216
-10F	102	116	130	144	158	172	186	200	214	
-15F	105	120	135	150	165	180	195	210		
-20F	108	124	140	156	172	188	204			

Table D-3. Header Temperature for a Building Reference Temperature of 65F

		RESET RATIO								
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
65	65	65	65	65	65	65	65	65	65	65
60	68	69	70	71	72	73	74	75	76	77
55	71	73	75	77	79	81	83	85	87	89
50	74	77	80	83	86	89	92	95	98	101
45	77	81	85	89	93	97	101	105	109	113
40	80	85	90	95	100	105	110	115	120	125
35	83	89	95	101	107	113	119	125	131	137
30	86	93	100	107	114	121	128	135	142	149
25	89	97	105	113	121	129	137	145	153	161
20	92	101	110	119	128	137	146	155	164	173
15	95	105	115	125	135	145	155	165	175	185
10	98	109	120	131	142	153	164	175	186	197
5	101	113	125	137	149	161	173	185	197	209
0	104	117	130	143	156	169	182	195	208	
-5	107	121	135	149	163	177	191	205	219	
-10	110	125	140	155	170	185	200	215		·
-15	113	129	145	161	177	193	209			
-20	116	133	150	167	201	218		-		•

Table D-4. Header Temperature for a Building Reference Temperature of 70F

					RESET	RATIO				
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
70F	70	70	70	70	70	70	70	70	70	70
65F	73	74	75	76	77	78	79	80	81	82
60F	76	78	80	82	84	86	88	90	92	94
55F	79	82	85	88	91	94	97	100	103	106
50F	82	86	90	94	98	102	106	110	114	118
45F	85	90	95	100	105	110	115	120	125	130
40F	88	94	100	106	112	118	124	130	136	142
35F	91	98	105	112	119	126	133	140	147	154
30F	94	102	110	118	126	134	142	150	158	166
25F	97	106	115	124	133	142	151	160	169	178
20F	100	110	120	130	140	150	160	170	180	190
15F	103	114	125	136	147	158	169	180	191	202
10F	106	118	130	142	154	166	178	190	202	214
5F	109	122	135	148	161	174	187	200	213	
0F	112	126	140	154	168	182	196	210		
-5F	115	130	145	160	175	190	205			
-10F	118	134	150	166	182	198	214	·	·	
-15F	121	138	155	172	189	206				
-20F	124	142	160	178	196	214				

APPENDIX D - INDOOR/OUTDOOR RATIO CHARTS

Table D-5. Header Temperature for a Building Reference Temperature of 75F

					RESET	RATIO				
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
75F	75	75	75	75	75	75	75	75	75	75
70F	78	79	80	81	82	83	84	85	86	87
65F	81	83	85	87	89	91	93	95	97	99
60F	84	87	90	93	96	99	102	105	108	111
55F	87	91	95	99	103	107	111	115	119	123
50F	90	95	100	105	110	115	120	125	130	135
45F	93	99	105	111	117	123	129	135	141	17
40F	96	103	110	117	124	131	138	145	152	159
35F	99	107	115	123	131	139	147	155	163	171
30F	102	111	120	129	138	147	156	165	174	183
25F	105	115	125	135	145	155	165	175	185	195
20F	108	119	130	141	152	163	174	185	196	207
15F	111	123	135	147	159	171	183	195	207	219
10F	114	127	140	153	166	179	192	205	218	
5F	117	131	145	159	173	187	201	215		
0F	120	135	150	165	180	195	210			
-5F	123	139	155	171	187	203	219			
-10F	126	143	160	177	194	211				
-15F	129	147	165	183	201	219				

Table D-6. Header Temperature for a Building Reference Temperature of 80F

					RESET	RATIO				
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
80F	80	80	80	80	80	80	80	80	80	80
75F	83	84	85	86	87	88	89	90	91	92
70F	86	88	90	92	94	96	98	100	102	104
65F	89	92	95	98	101	104	107	110	113	116
60F	92	96	100	104	108	112	116	120	124	128
55F	95	100	105	110	115	120	125	130	135	140
50F	98	104	110	116	122	128	134	140	146	152
45F	101	108	115	122	129	136	143	150	157	164
40F	104	112	120	128	136	144	152	160	168	176
35F	107	116	125	134	143	152	161	170	179	188
30F	110	120	130	140	150	160	170	180	190	200
25F	113	124	135	146	157	168	174	190	201	212
20F	116	128	140	152	164	176	188	200	212	
15F	119	132	145	158	171	184	197	210		
10F	122	136	150	164	178	192	206			
5F	125	140	155	170	185	200	215	-		
0F	128	144	160	176	192	208				
-5F	131	148	165	182	199	216	-			
-10F	134	152	170	188	206					

OMM-0082_0J GF-130

AERCO International, Inc. • 100 Oritani Dr. • Blauvelt, NY 10913 Ph.: 800-526-0288

APPENDIX D - INDOOR/OUTDOOR RATIO CHARTS

Table D-7. Header Temperature for a Building Reference Temperature of 90F

					RESET	RATIO				
Air Temp	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
90F	90	90	90	90	90	90	90	90	90	90
85F	93	94	95	96	97	98	99	100	101	102
80F	96	98	100	102	104	106	108	110	112	114
75F	99	102	105	108	111	114	117	120	123	126
70F	102	106	110	114	118	122	126	130	134	138
65F	105	110	115	120	125	130	135	140	145	150
60F	108	114	120	126	132	138	144	150	156	162
55F	111	118	125	132	139	146	153	160	167	174
50F	114	122	130	138	146	154	162	170	178	186
45F	117	126	135	144	153	162	171	180	189	198
40F	120	130	140	150	160	170	180	190	200	210
35F	123	134	145	156	167	178	189	200		
30F	126	138	150	162	174	186	198	210		
25F	129	142	155	168	181	194	207			
20F	132	146	160	174	188	202	216			
15F	135	150	165	180	195	210				
10F	138	154	170	186	202	218				
5F	141	158	175	192	209					
0F	144	162	180	198	216					

APPENDIX E - BOILER DEFAULT SETTINGS

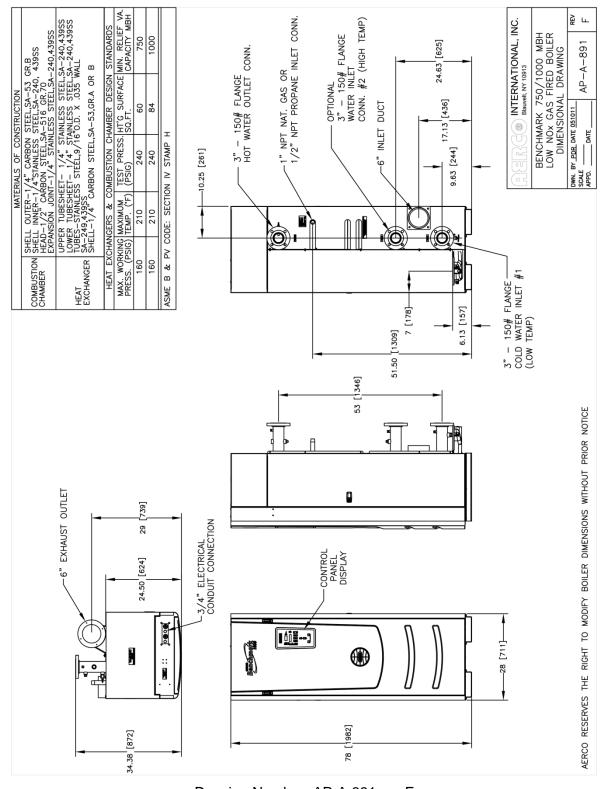
MENU & OPTION	FACTORY DEFAULT					
Setup	Menu					
Password	0					
Language	English					
Unit of Temp	Fahrenheit					
Comm Address	0					
Baud Rate	9600					
Configura	tion Menu					
Internal Setpt	130°F					
Unit Type	BMK Boiler LN					
Unit Size	750 MBH or 1000 MBH					
Fuel Type	Natural Gas					
Boiler Mode	Constant Setpoint					
Remote Signal (If Mode = Remote Setpoint, Direct Drive or Combination)	4 – 20 mA / 1-5V					
Bldg Ref Temp (If Boiler Mode = Outdoor Reset)	70°F					
Reset Ratio (If Boiler Mode = Outdoor Reset)	1.2					
Outdoor Sensor	Disabled					
System Start Tmp (If Outdoor Sensor = Enabled)	60°F					
Setpt Lo Limit	60°F					
Setpt Hi Limit	195°F					
Temp Hi Limit	195°F					
Max Valve Position	100%					
Pump Delay Timer	0 min					
Aux Start On Dly	0 sec					
Failsafe Mode	Shutdown					
Analog Output	Valve Position 0-10V CAUTION: DO NOT Change					
Lo Fire Timer	2 sec					

APPENDIX E – BOILER DEFAULT SETTINGS

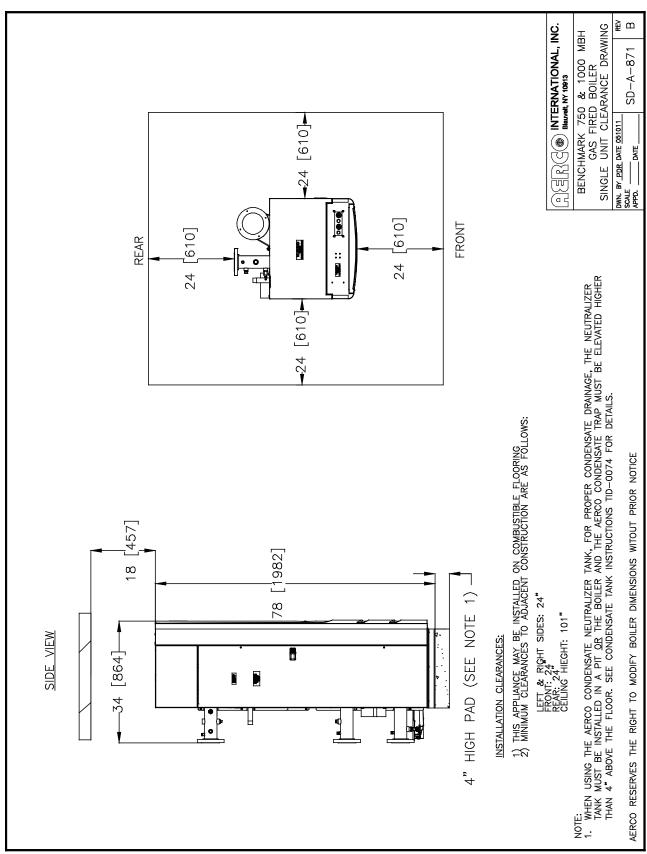
BOILER DEFAULT SETTINGS – Continued

MENU & OPTION	FACTORY DEFAULT			
Configuration	n Menu (Cont.)			
Setpt Limit Band (If Setpt Limiting = Enabled)	5°F			
Network Timeout	30 seconds			
Hi DB Setpt En	30			
Demand Offset	10			
Deadband High	2			
Deadband Low	2			
Tuning Menu				
Prop Band	70°F			
Integral Gain	1.00			
Derivative Time	0.0 min			

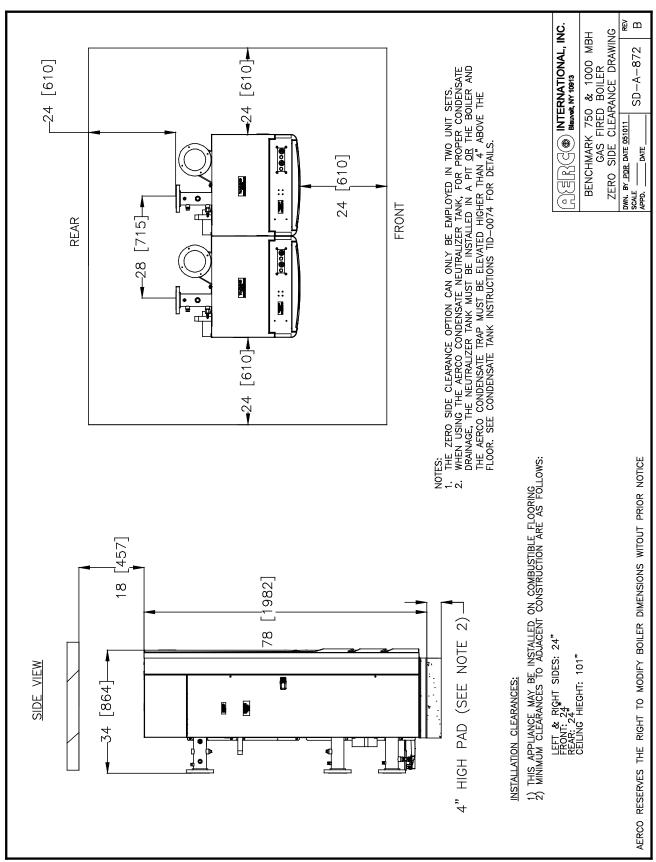
APPENDIX F - DIMENSIONAL DRAWINGS



Drawing Number: AP-A-891 rev F



Drawing Number: SD-A-871 rev B



Drawing Number: SD-A-872 rev B

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual APPENDIX F - DIMENSIONAL DRAWINGS (This Page Is Intentionally Blank)

APPENDIX G - PARTS LIST DRAWINGS

APPENDIX G - PART LIST DRAWINGS

Benchmark 750 - 1000 Parts List

Item#	Qty	Part #	Description	Item #	Qty	Part #	Description
EXHAUS	ST MAN	IFOLD		CONTRO	LS (Cont	inued)	
1	1	43086	MANIFOLD: EXHAUST	31	1	61002-5	BLOCKED INLET SWITCH -8.0" W.C.
2	1	84033	SEAL: EXHAUST MANIFOLD	32	1	65085	TRANSFORMER: IGNITION
3	1	9-22	PIPE PLUG: 1/4" NPT: STEEL	33	1	65119	POWER OUTLET: DIN MOUNT
				34	2	69141	DIN RAIL MOUNT END STOP
GAS TRAIN ASSEMBLY				35	1	64081	ECU
	1	22140-1	STD FM GAS TRAIN ASSY	36	1	65011	TRANSFORMER 115V/24V 100VA
4	1	22140-2	DBB GAS TRAIN ASSY	37	1	65109	12V POWER SUPLY
	1	22140-3	PROPANE GAS TRAIN ASSY				
5	1	99017	SNUBBER: PRESSURE: 1/4"	380	1	69145	RAIL: DIN: 8 1/2" LG
6	1	81155	GASKET: 1 1/4" PIPE FLANGE	39	2	65120	TERMINAL BLOCK: DIN MOUNTED: BLK
7	1	61002-1	PRESSURE SWITCH: 2.6" W.C. FALL N.O.	40	2	65121	TERMINAL BLOCK: DIN MOUNTED: WHT
9	1	61002- 12	HIGH GAS PRESSURE SWITCH 4.7" W.C.	41	3	65122	TERMINAL GROUND BLOCK: DIN MOUNTED
10	1	92077	1/4" NPT MXF BRASS BALL VALVE	42	2	65118	FUSE TERMINAL: DIN MOUNTED
			, .	43	1	69177	LIMIT CONTROL TEMP CONTROLLER
BURNER, AIR/FUEL VALVE, HEAT EXCHANGER			44	1	69005	ACTUATOR, SSOV w PRESSURE REG	
11	1	46026	BURNER: BMK 1.0	45	1	24327	ASSEMBLY: POWER SUPPLY COVER
	1	24367-1	BMK 1000 A/F Valve FRU kit	46	1	60019	DISCONNECT: FUSIBLE
12	1	24367-2	BMK 750 A/F Valve FRU kit	470	2	124512	FUSE: 4 AMP
13	1	24277	STAGED IGNITION ASSY	48	1	123449	SENSOR: TEMPERATURE
14	1	81143	GASKET: BURNER	49	1	93359	THERMOWELL
15	1	59171	REFLECTOR: SIGHT GLASS	50	1	33137	ELECTRICAL PANEL
16	1	59104	OBSERVATION PORT	51	1	181197	CONTROL BOX: C-MORE
	1	28317	BMK 750 HEAT EXCHANGER	52	1	69151	PCB ASSY
17	1	28249	BMK 1000 HEAT EXCHANGER	53	2	124326	RELAY: OMRON MY2DC24[S]
				54	2	51006	CLIP: HOLD-DOWN
HOSES 8	& INSUI	ATION		55 0	1	63097	I/O SENSOR/COMM HARNESS
18	1	97005-5	TUBE: FLEXIBLE GAS 18"	56 0	1	63090	TEMP LIM CONT PWR HARNESS
19	1	80080	INSULATION: SHELL	57 0	1	124327	HARNESS: INTERLOCK HARNESS
				58 0	1	63086	SHELL HARNESS
				59 0	1	63147	HARNESS: WIRING: GAS TRAIN
BLOWE	R			60	1	65156	FLAME ROD SIGNAL AMPLIFIER
20	1	58061	BMK BLOWER REPLACEMENT KIT	61	1	61030	OUTLET TEMP SENSOR
22	1	81064	GASKET: BLOWER	62	1	61024	AIR INLET TEMPERATURE SENSOR
23	1	88004	O-RING #2-244 BUNA-N	63 0	1	65104	CABLE: H.V. IGNITION
24	1	24356-1	FLAME DETECTOR KIT	64 0	1	63083	HARNESS: O2 SENSOR
25	1	61026	LEAN OXYGEN SENSOR	65 0	1	63085	CONTROL HARNESS: BMK 1000 & 750
26		58023	IGNITOR REPLACEMENT KIT	67	1	69038	ACCTUATOR, SSOVE w/o P.O.C. SWITCH
27	1	59139	AIR FILTER: 6" X 4.5 LG	68	1	GP-122774	VALVE, VENT 3/4"
			1	69			24V POWER SUPLY (SEQUENCING
CONTRO	OLS		I		1	65162	ISOLATION VALVE)
28	1	123966	SWITCH: OVER TEMP-AUTO RESET				
29	1	123552	SWITCH: OVER TEMP-MANUAL RESET				
				1			

NOT SHOWN ON DRAWINGS BELOW

60011-1 SWITCH ASSY: BLOWER PROOF

AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 Part List	03/07/2014
10913	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 1 of 6

APPENDIX G - PARTS LIST DRAWINGS

Benchmark 750 - 1000 Parts List

Item#	Qty	Part #	Description	Item #	Qty	Part #	Description
SHEET M	SHEET METAL/PANEL ASSEMBLY		OTHER A	OTHER ACCESSORIES / PARTS			
						SEE TABLE	
70	1	37110	PANEL: LEFT	85	1	Α	3/4 " CLOSE NIPPLE
						SEE TABLE	
71	1	37111	PANEL: RIGHT	86 ❶	1	Α	PRESS./TEMP GAUGE
		27444	001/50 4001/	07.0		SEE TABLE	DDESCURE DELICE VALVE WE
72	1	37114	COVER ASSY	87 🛈	1	Α	PRESSURE RELIEF VALVE KIT
73	1	25068	ASSEMBLY: FRONT PANEL	88 0	1	92006-5	VALVE: BALL 1" NPT
74	1	25078	ASSEMBLY: FRONT PANEL	89	1	122843	LOW WATER CUTOFF
75	1	72068	LABEL: DOME	90	1	123863	VALVE: BALL 1/8" NPT
76	2	59179	HANDLE: CONCEALED PULL	91	1	92094	VALVE: 3/4 BOILER DRAIN MNPT x GHT
77	2	59133	LATCH: COMPRESSION	92 🛈	1	59043	CONDENSATE FLOAT
78	1	50010	LATCH: DRAW	93 🛈	1	24060	COND. TRAP ASSEMBLY
79	1	50011	KEEPER: DRAW LATCH	94	1	59178	VENT: AIR 1/8 NPT
	1	74023	LOGO LABEL, BMK 1000	95	1	124008	NIPPLE: 1/8 NPT X 3.00" LG
80							MOTORIZED SEQUENCING ISOLATION
		74026	LOGO LABEL, BMK 750	100 ❶	1	92084-6	VALVE (OPTIONAL)
81	4	123621	BOLT, HEX HD 1/4-20 X .50 LG.	1010	1	63150	HARNESS: FLAME ROD
82	1	39125	ADAPTER: AIR INLET 6" PVC				

NOTES:

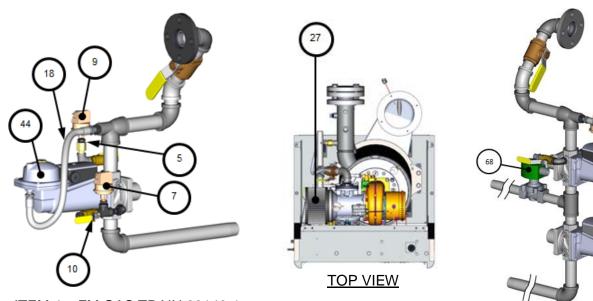
1 NOT SHOWN ON DRAWINGS BELOW

TABLE A

Item 85	Item 86	Item 87	Available in Kit Number	Description
9-234	69087-2	92015-1	58037-1	30 PSI Kit (Apollo)
NOT REQUIRED	69087-2	92014	58037-2	50 PSI Kit (Conbraco)
9-234	69087-3	92015-20	58037-3	75 PSI Kit (Apollo)
9-234	69087-3	92015-15	58037-4	100 PSI Kit (Watts)
9-234	69087-4	123659	58037-5	150 PSI Kit (Watts)
9-234	69087-3	92015-13	58037-6	60 PSI Kit (Watts)
9-234	69087-3	92015-16	58037-7	125 PSI Kit (Watts)
9-234	69087-4	92015-23	58037-8	160 PSI Kit (Kunkle)

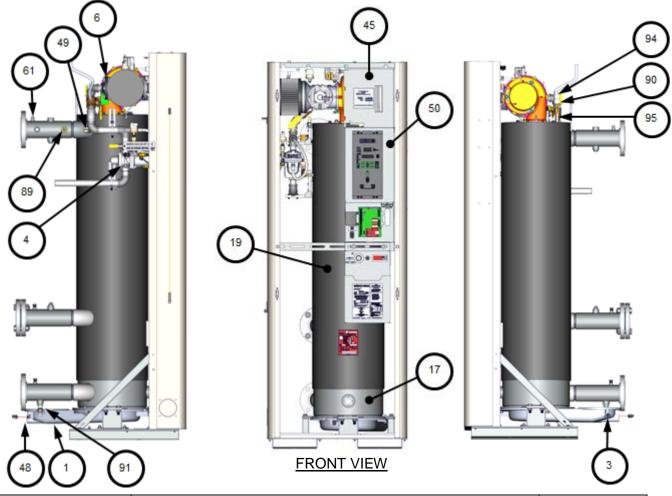
AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 Part List	03/07/2014
10913	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 2 of 6

APPENDIX G - PARTS LIST DRAWINGS



ITEM 4 - FM GAS TRAIN 22140-1

ITEM 4 - DBB GAS TRAIN 22140-2

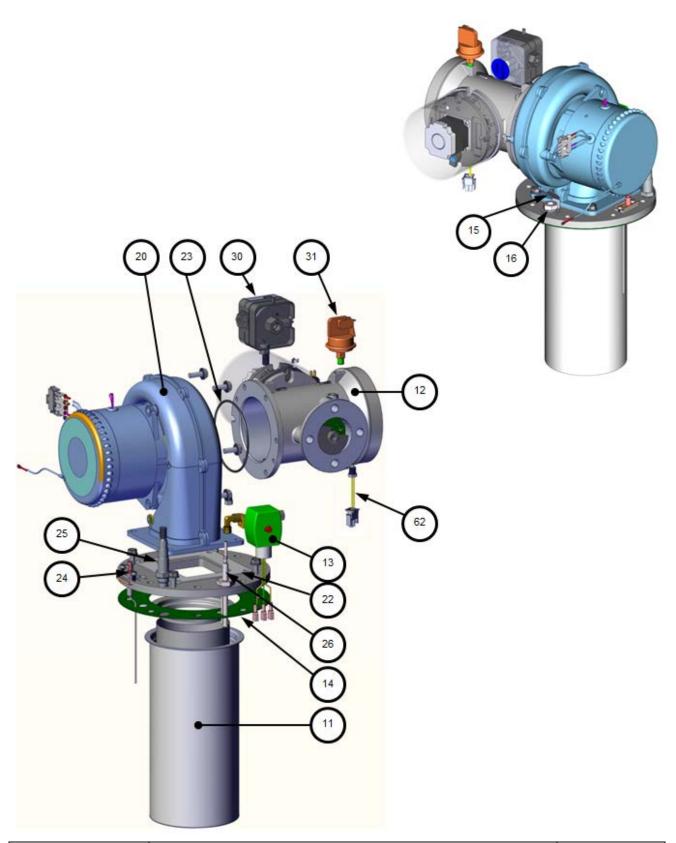


AERCO International, Inc. Blauvelt, NY 10913

Benchmark 750-1000 Part List 03/07/2014

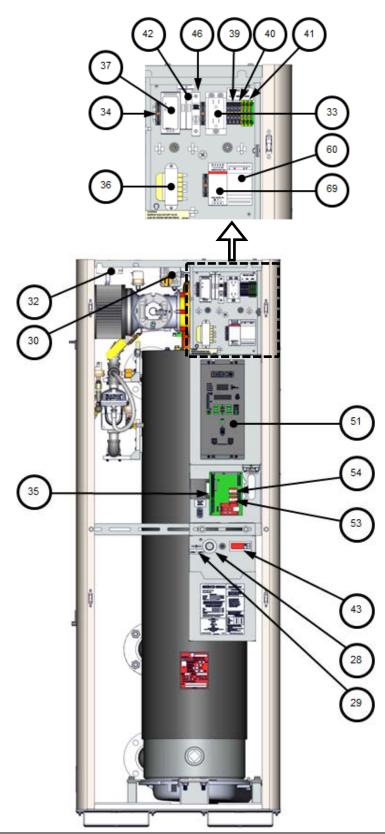
28321-1 rev D, 28253-1 rev F (reference PL-A-173) Sheet 3 of 6

APPENDIX G - PARTS LIST DRAWINGS



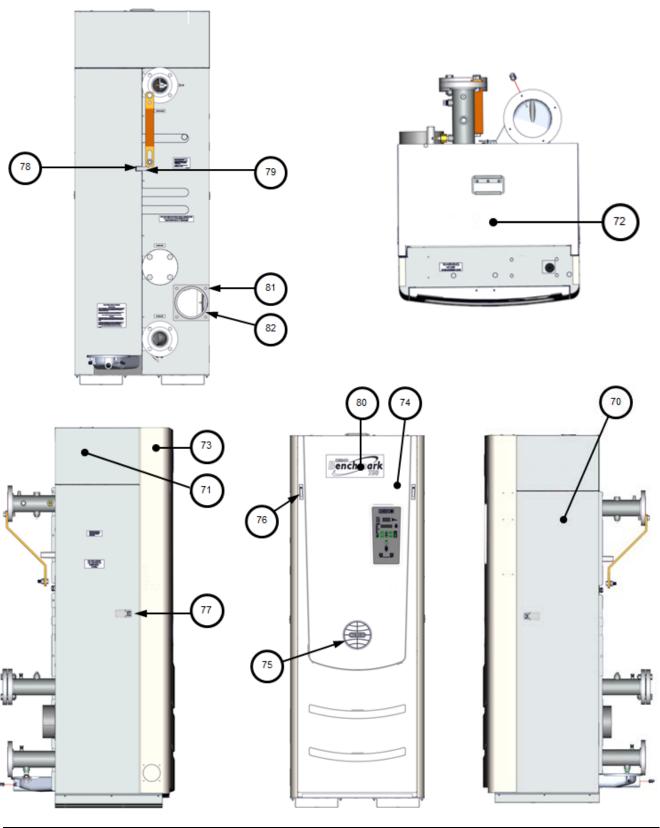
AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 Part List	03/07/2014
10913	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 4 of 6

APPENDIX G - PARTS LIST DRAWINGS



AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 Part List	03/07/2014
10913	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 5 of 6

APPENDIX G - PARTS LIST DRAWINGS



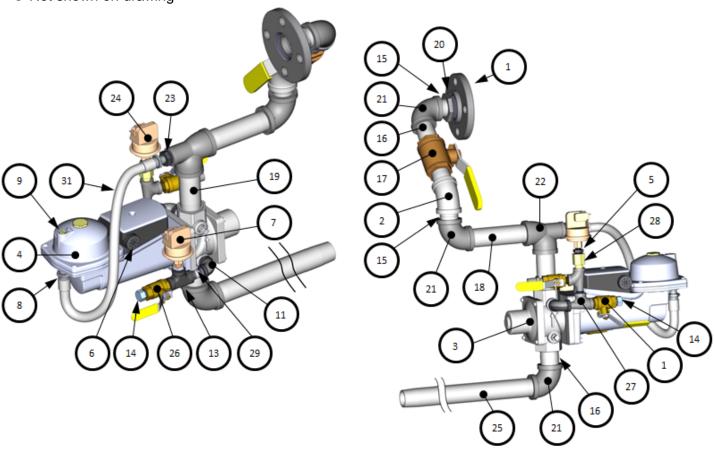
AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 Part List	03/07/2014
10913	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 6 of 6

APPENDIX G - PARTS LIST DRAWINGS

Benchmark 750-1000 FM Gas Train - 22140-1 rev E

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	95026	1.25"NPT 125#: THREADED FLANGE	17	1	92006-5	VALVE: BALL 1" NPT
2	1	93046	ELBOW: 45 <mod-deg>: 1": B/I: 150#</mod-deg>	18	1	94028-5.00	NIPPLE: 1" NPT TBE X 5.00 LG
3	1	92036	VALVE: SSOV 1" NPT	19	1	94028-3.50	NIPPLE: 1" NPT TBE X 3.50 LG
4	1	69005	ACTUATOR: SSOV W/ REGULATOR	20	1	12609-10-8	1 1/4 x 1 HEX. RED. BUSHING
5	2	123536	BUSHING: REDUCING 1/4" X 1/8" NPT	21	3	9-222	ELBOW: 90 <mod-deg>: 1" NPT: M/I</mod-deg>
6	2	12951-2	BUSHING: CONTROL BOX	22	1	93364	TEE 1 X 1 X 1/2 NPT
7	1	61002-1	PRESSURE SWITCH: 2.6" W.C. FALL N.O.	23	1	123311	BUSHING: REDUCING 1/2" NPT X 1/4" NPT
8	3	99014	NIPPLE: HEX 1/4" NPT X 3/8" NPT	24	1	61002-12	HIGH GAS PRESSURE SWITCH 4.7" W.C.
9	1	99015	DAMPING ORIFICE: SSOV	25	1	94028-13.25	NIPPLE: 1" NPT TBE X 13.25 LG
10 0	1	63147	HARNESS: WIRING: GAS TRAIN	26	3	92077	1/4" NPT MXF BRASS BALL VALVE (OPEN)
11	2	124084	ELBOW: 1/4" NPT 150# M/I	27	2	93290	TEE MXFXF BLACK IRON 1/4" NPT
12 0	1	124862	RESISTOR ASSY	28	1	99017	SNUBBER: PRESSURE: 1/4"
13	1	124083	TEE 1/4" NPT: 150#	29	1	124151	1/4" NPT SCH. 40 X 1-1/2" LG NIPPLE
14	2	9-22	PIPE PLUG: 1/4" NPT: STEEL	30	2	12607-2	CLOSE NIPPLE: 1/4" NPT SCH.40: C.S.
15	2	9-331	NIPPLE: 1" NPT TBE X 1.50 LG	31	1	97005-5	TUBE: FLEXIBLE GAS 18"
16	3	94028- 2.00	NIPPLE: 1" NPT TBE X 2.00 LG				

Not shown on drawing



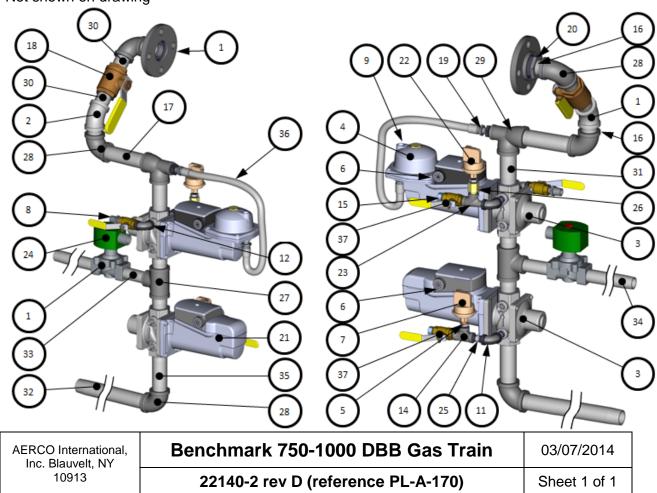
AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 FM Gas Train	03/07/2014
10913	22140-1 rev E (reference PL-A-169)	Sheet 1 of 1

APPENDIX G - PARTS LIST DRAWINGS

Benchmark 750-1000 DBB Gas Train - 22140-2 rev D

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	95026	1.25"NPT 125#: THREADED FLANGE	20	1	12609-10-8	1 1/4 x 1 HEX. RED. BUSHING
2	1	93046	ELBOW: 45 <mod-deg>: 1": B/I: 150#</mod-deg>	21	1	69038	ACTUATOR: SSOV W/O P.O.C. SWITCH
3	2	92036	VALVE: SSOV 1" NPT	22	1	61002-12	HIGH GAS PRESSURE SWITCH 4.7" W.C.
4	1	69005	ACTUATOR: SSOV W/ REGULATOR	23	1	93290	TEE MXFXF BLACK IRON 1/4" NPT
5	2	123536	BUSHING: REDUCING 1/4" X 1/8" NPT	24	1	122774	VALVE: VENT 3/4" NPT
6	4	12951-2	BUSHING: CONTROL BOX	25	3	124151	1/4" NPT SCH. 40 X 1-1/2" LG NIPPLE
7	1	61002-1	PRESSURE SWITCH: 2.6" W.C. FALL N.O.	26	1	99017	SNUBBER: PRESSURE: 1/4"
8	3	99014	NIPPLE: HEX 1/4" NPT X 3/8" NPT	27	1	93187	TEE:REDUCING 1" X 3/4 X 1"
9	1	99015	DAMPING ORIFICE: SSOV	28	3	9-222	ELBOW: 90 <mod-deg>: 1" NPT: M/I</mod-deg>
10	1	63147	HARNESS: GAS TRAIN WIRING [4 SEC. IGN.]	29	1	93364	TEE 1 X 1 X 1/2 NPT
11	3	124084	ELBOW: 1/4" NPT 150# M/I	30	4	94028-2.00	NIPPLE: 1" NPT TBE X 2.00 LG
12	1	12607-2	CLOSE NIPPLE: 1/4" NPT SCH.40: C.S.	31	1	94028-3.50	NIPPLE: 1" NPT TBE X 3.50 LG
13 0	1	124862	RESISTOR ASSY	32	1	94028-13.25	NIPPLE: 1" NPT TBE X 13.25 LG
14	1	124083	TEE 1/4" NPT: 150#	33	1	94061-3.00	NIPPLE: 3/4" NPT X 3.00 LG
15	2	9-22	PIPE PLUG: 1/4" NPT: STEEL	34	1	94061-8.00	NIPPLE: 3/4" NPT X 8.00 LG
16	2	9-331	NIPPLE: 1" NPT TBE X 1.50 LG	35	1	94028-4.25	NIPPLE: 1" NPT TBE X 4.25 LG
17	1	94028- 5.00	NIPPLE: 1" NPT TBE X 5.00 LG	36	1	97005-5	TUBE: FLEXIBLE GAS 18"
18	1	92006-5	VALVE: BALL 1" NPT	37	3	92077	1/4" NPT MXF BRASS BALL VALVE (OPEN)
19	1	123311	BUSHING: REDUCING 1/2" NPT X 1/4" NPT				•

Not shown on drawing

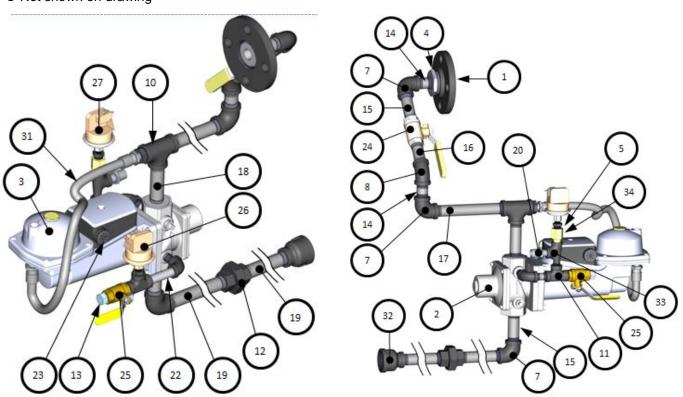


APPENDIX G – PARTS LIST DRAWINGS

BMK 750-1000 PROPANE Gas Train - p/n 22140-3 rev C

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	95026	1.25"NPT 125#: THREADED FLANGE	19	2	90104	NIPPLE: PIPE ½' NPT SCH 40 x 7.00 LG BLK STL
2	1	92103	VALVE: SSOV 1/2" NPT	20	3	99014	NIPPLE: HEX 1/4" NPT X 3/8" NPT
3	1	69005	ACTUATOR: SSOV W/ REGULATOR	21	3	124151	1/4" NPT SCH. 40 X 1-1/2" LG NIPPLE
4	1	93422	BUSHING: HEX REDUCING 1¼ x ½ NPT BLK M.I.	22	1	124088	NIPPLE: 1/4" NPT: C.S. 2 1/2" LONG
5	2	123536	BUSHING: REDUCING 1/4" X 1/8" NPT	23	2	12951-2	BUSHING: CONTROL BOX
6	1	123311	BUSHING: REDUCING 1/2" NPT X 1/4" NPT	24	1	92006-3	VALVE: FULL PORT BALL 1/2" NPT BRASS
7	3	93419	ELBOW: 90° FEMALE ½" NPT BLACK MI	25	2	92077	1/4" NPT MXF BRASS BALL VALVE (OPEN)
8	1	93423	ELBOW 45° FEMALE ½" NPT BLK M.I.	26	1	61002-8	BMK750 LOW GAS PRESSURE SWITCH 4.4" W.C.
9	2	124084	ELBOW: 1/4" NPT 150# M/I	20	1	61002-8	BMK1000 LOW GAS PRESSURE SWITCH 7.5" W.C.
10	1	93418	TEE ½" NPT BLACK MI	27	1	61002-12	BMK750 HIGH GAS PRESSURE SWITCH 4.7" W.C.
11	2	124083	TEE 1/4" NPT: 150#	21	1	61002-17	BMK1000 HIGH GAS PRESSURE SWITCH 10.5" W.C.
12	1	93420	UNION ½" NPT FEMALE BLACK MI	280	1	63142	WIRE: PRESS SW JUMPER
13	2	9-22	PIPE PLUG: 1/4" NPT: STEEL	29 0	1	161450	HARNESS: WIRING: GAS TRAIN
14	2	90099	NIPPLE ½ x 2.00 SCH 40 BLK STL	30 0	1	124862	RESISTOR ASSY
15	2	90100	NIPPLE ½ x 3.00 SCH 40 BLK STL	31	1	97005-5	TUBE: FLEXIBLE GAS 18"
16	1	90107	NIPPLE PIPE ½" NPT SCH 40 x 2½" LG BLK STL	32	1	93474	1 X 1/2" REDUCING COUPLING: B/ I
17	1	90102	NIPPLE ½ x 6.00 SCH 40 BLK STL	33	1	93290	TEE MXFXF BLACK IRON 1/4" NPT
18	1	90105	NIPPLE: PIPE ½" NPT SCH 40 x 3½ LG BLK STL	34	1	99017	SNUBBER: PRESSURE: 1/4"

Not shown on drawing

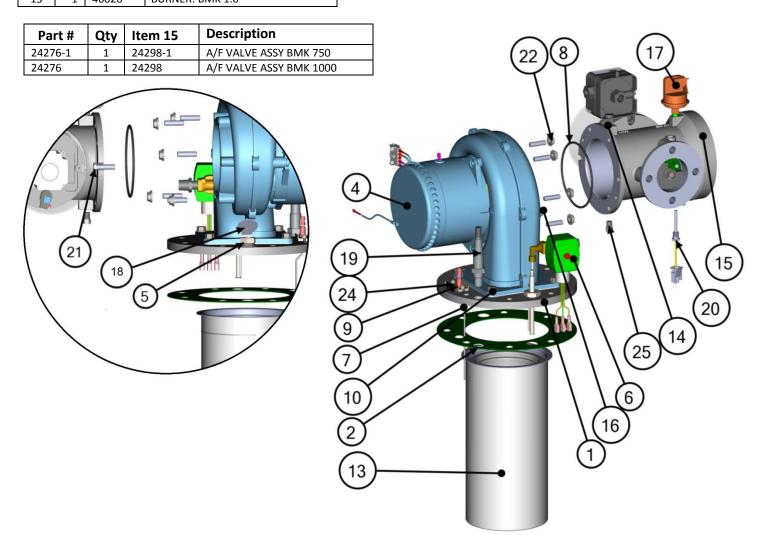


AERCO International, Inc.	Benchmark 750-1000 Gas Train – Propane	04/02/2014
Blauvelt, NY 10913	22140-3 rev C	Sheet 1 of 1

APPENDIX G - PARTS LIST DRAWINGS

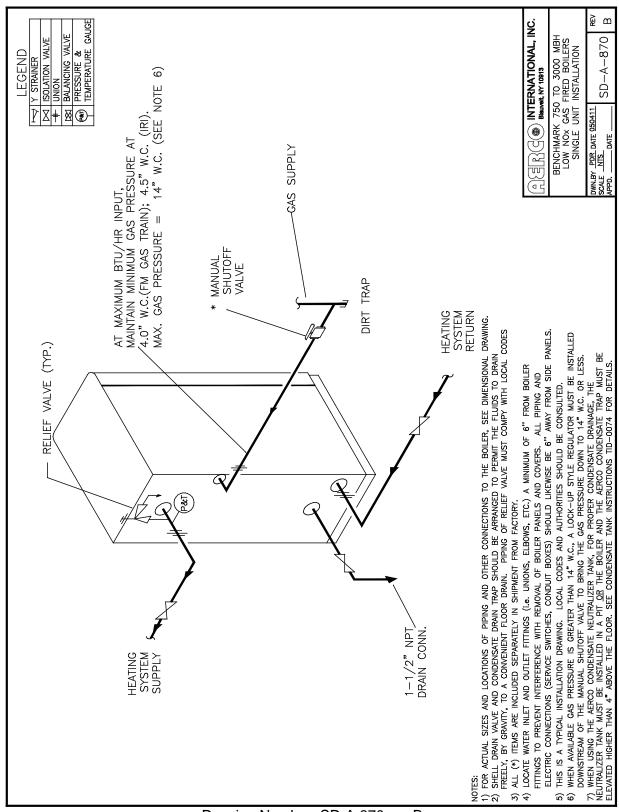
Benchmark 750-1000 Burner BOM (ref p/n 24276 rev F)

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	42140	PLATE: BURNER	14	1	123533	NIPPLE: CLOSE 1/8"
2	1	81143	GASKET: BURNER	15	1	See Table	A/F VALVE ASSY
3	1	81064	GASKET: BLOWER	16	6	52027	M8 X 1.25 STUD: 30mm LENGTH
4	1	24111	BLOWER: AMETEK 8.9"	17	1	61002-5	BLOCKED INLET SWITCH -8.0" W.C.
5	1	59104	OBSERVATION PORT	18	1	59171	REFLECTOR: SIGHT GLASS
6	1	24277	STAGED IGNITION ASSY	19	1	61026	LEAN OXYGEN SENSOR
7	1	66020	FLAME DETECTOR	20	1	61024	AIR INLET TEMPERATURE SENSOR
8	1	88004	O-RING #2-244 BUNA-N	21	1	56064	NUT: M8 X 1.25 HEX JAM
			GASKET: FLAME DETECTOR LOW				
9	1	81048	NOX	22	5	56060	NUT: M8 X 1.25 FLANGED SERRATED
10	4	54028	SCREW: HEX HD SERRATED 5/16-18	23	2	54095	SCREW: SOC HD #10-32 X 3/8 LG
11	1	60011-1	SWITCH ASSY: BLOWER PROOF	24	1	66026	IGNITOR-INJECTOR
12	3	53033	WASHER: CLOCKING	25	1	9-21	PLUG: HEX HD 1/8 NPT
13	1	46026	BURNER: BMK 1.0				



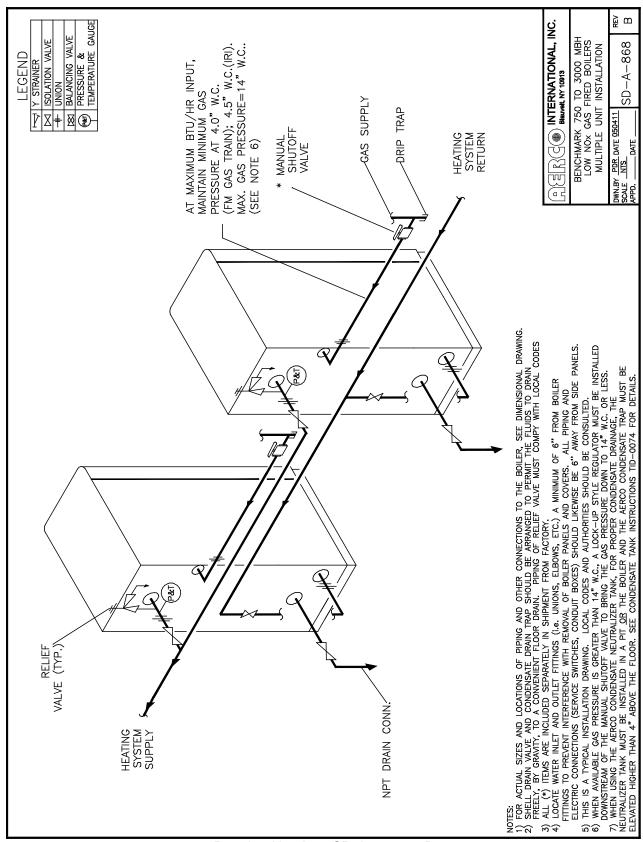
AERCO International, Inc. Blauvelt, NY	Benchmark 750-1000 Burner Assembly	08/06/2013
10913	24276 rev F (AP-A-171)	Sheet 1 of 1

APPENDIX H - PIPING DRAWINGS



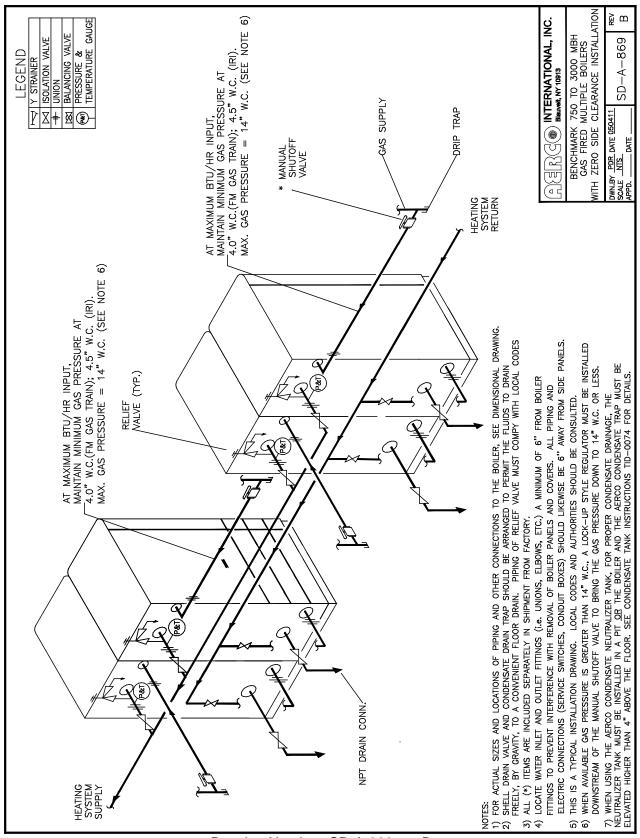
Drawing Number: SD-A-870 rev B

APPENDIX H - PIPING DRAWINGS



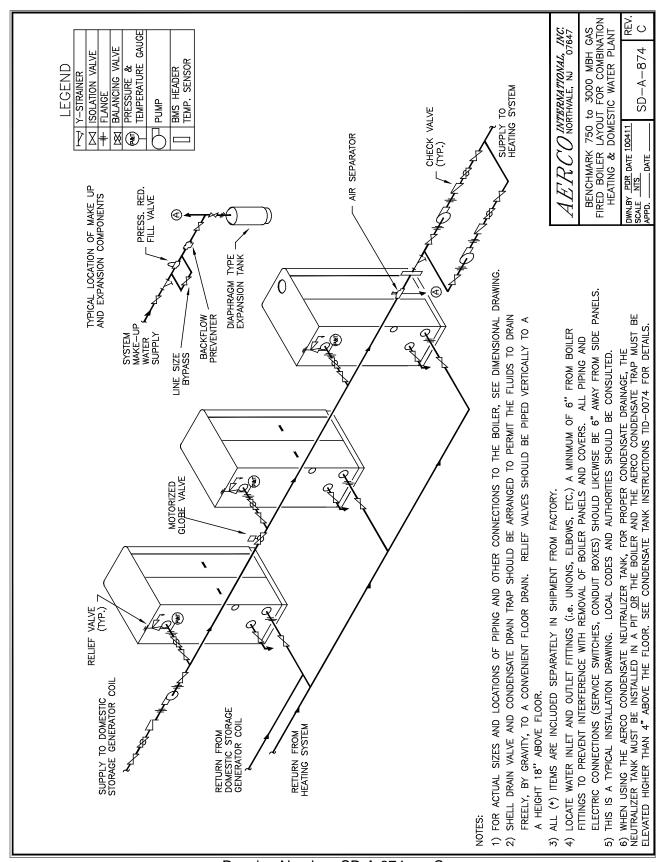
Drawing Number: SD-A-868 rev B

APPENDIX H - PIPING DRAWINGS



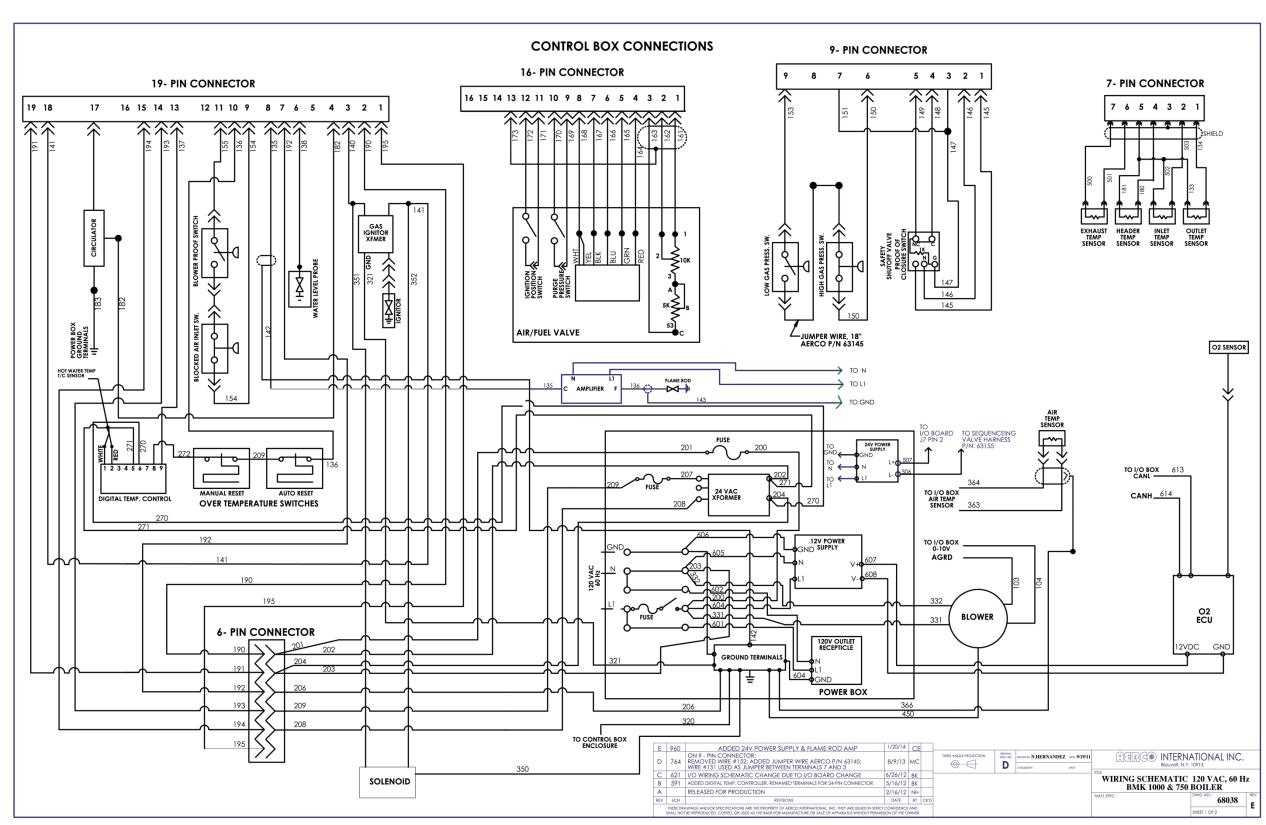
Drawing Number: SD-A-869 rev B

APPENDIX H - PIPING DRAWINGS



Drawing Number: SD-A-874 rev C

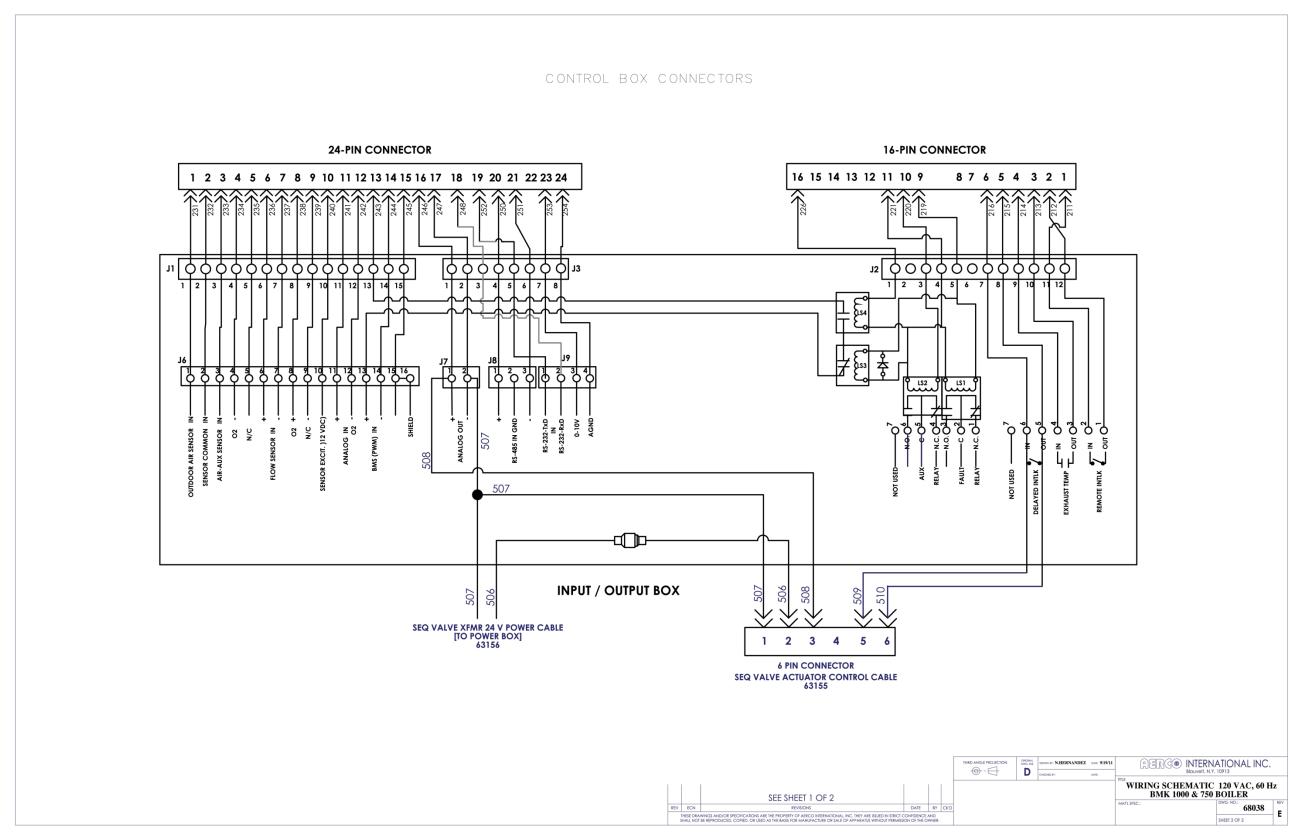
APPENDIX I – C-MORE WIRING DIAGRAMS



Drawing Number: 68038 rev E Sheet 1 of 2

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual APPENDIX I – C-MORE WIRING DIAGRAMS

This Page Is Intentionally Blank



Drawing Number: 68038 rev E Sheet 2 of 2

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual APPENDIX I – C-MORE WIRING DIAGRAMS

This Page Is Intentionally Blank

APPENDIX J - RECOMMENDED PERIODIC TESTING

WARNING

Periodic testing of all boiler controls and safety devices is required to determine that they are operating as designed. Precautions shall be taken while tests are being performed to protect against bodily injury and property damage. The owner or user of an automatic boiler system should set up a formal system of periodic preventive maintenance and testing. Tests should be conducted on a regular basis and the results recorded in a log-book.

Table J1: Recommended Periodic Testing

rable 31. Neconimended renodic resting					
Item	Frequency	Accomplished By	Remarks		
Refer to indicated sections of this manual for detailed procedures					
Gauges, monitors and indicators	Daily	Operator	Visual inspection and record readings in operator log		
Instrument and	Daily	Operator	Visual check against factory recommended specifications		
equipment settings	Weekly	Operator	Verify factory settings		
Firing Poto Control	Semi- Annually	Service Technician	Verify factory settings		
Firing Rate Control	Annually	Service Technician	Check with combustion calibration test equipment. See section 7.4 and Chapter 4.		
Flue, vent, stack or intake air duct	Monthly	Operator	Visually inspection condition and check for obstructions		
Spark Igniter-Injector	Weekly	Operator	See section 7.2		
Air/Fuel Valve position	Weekly	Operator	Check position indicator dial (section 3.11)		
SSOV Leakage test	Annually	Service Technician	Check for leakage in accordance with the SSOV manufacturer's (Siemens) recommendations.		
Flame failure	Weekly	Operator	Close manual gas shutoff valve and check safety shutdown. See section 6.7		
Flame signal strength	Weekly	Operator	Check flame strength using the Control Panel Operating Menu. See section 3.4.		
Low water level cut off and alarm	Weekly	Operator	See section 6.4		
Slow drain test	Semi- Annually	Operator	Perform a slow drain test in accordance with ASME Boiler and Pressure Vessel Code, Section IV.		
High water temperature safety control test	Annually	Service Technician	See section 6.5		
Operating controls	Annually	Operator	See section 3.2		
		l	I .		

APPENDIX J – RECOMMENDED PERIODIC TESTING

Item	Frequency	Accomplished By	Remarks
Low air flow	Monthly	Operator	See section 6.8
High and low gas pressure interlocks	Monthly	Operator	See sections 6.2 and 6.3
Air/Fuel Valve purge position switch	Annually	Service Technician	See section 6.10
Air/Fuel Valve ignition position switch	Annually	Service Technician	See section 6.11
Safety valves	As required	Operator	Check per A.S.M.E. Boiler and Pressure Vessel Code, Section IV
Inspect burner components	Semi- Annually	Service Technician	See section 7.7
Condensate Trap	Semi- Annually	Operator	See section 7.8
Oxygen (O ₂) Level	Monthly	Operator	Verify oxygen level is between 3% and 8% during boiler operation

APPENDIX K – C-MORE CONTROL PANEL VIEWS

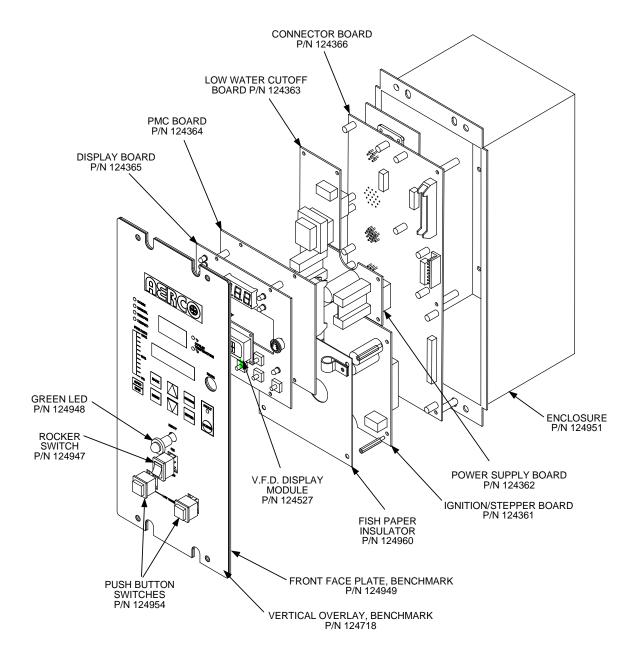


Figure K-1: Benchmark Control Panel Exploded View

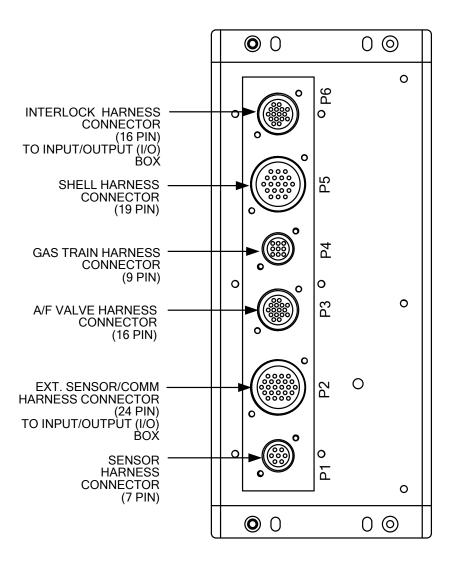


Figure K-2: Benchmark Control Panel Rear View

APPENDIX L: RECOMMENDED SPARES

NOTE

Refer to the Parts List Illustrations in Appendix G for the locations of the recommended and optional spare parts listed in the following Tables.

Table L-1: Recommended Emergency Spare Parts

DESCRIPTION	PART NUMBER
120 VAC/Single-Phase Blower	58061
SSOV Actuator/Regulator Combo - Used on:	64048
ALL FM gas train models	
Downstream SSOV of IRI gas train models	
SSOV Actuator Without Proof of Closure Switch - Used on:	69038
Upstream SSOV of IRI gas train models	
Temperature Switch - Manual Reset	123552
Staged Ignition Assembly	24277

Table L-2: Spare Parts Recommended for Maintenance

DESCRIPTION	PART NUMBER
Annual Maintenance Kit	58025-01
24-month Waterside/Fireside Inspection Kit	58025-08

Table L-3: Optional Spare Parts

DESCRIPTION	PART NUMBER
C-More Control Box	181197
Burner	46023
Lean Oxygen Sensor	61026
Temperature Switch - Auto Reset (See Note)	123966
Limit Control – Temperature Digital Controller	69177

NOTE

If the unit is installed in the state of Kentucky, contact your local AERCO Sales Representative for a Temperature Switch rated for 200°F.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual APPENDIX K - RECOMMENDED SPARES (This Page Is Intentionally Blank)

APPENDIX M – ULTRA-LOW NOX CALIBRATION

M-1. ULTRA-LOW NOX COMBUSTION CALIBRATION

The procedures provided in this Appendix are used to combustion calibrate the boiler to produce ultra-low NOx emissions of less than 9 ppm when running on natural gas.

NOTE

The instructions below do not apply to units running Propane gas.

If the ultra-low NOx requirement was specified on the Sales Order, the Benchmark Boiler was combustion calibrated at the factory prior to shipping. However, recalibration as part of initial start-up is necessary due to changes in the local altitude, gas BTU content, gas supply piping and supply regulators. Factory Test Data sheets are shipped with each unit. These sheets must be filled out and returned to AERCO for proper Warranty Validation.

Prior to performing the procedure in this Appendix, the boiler must be set up as described in Chapter 4, section 4.1 through the **low NOx** combustion calibration in section 4.3. Once that is complete, perform the following steps to combustion calibrate the boiler to the **ultra-low NOx** requirement of less than 9 ppm.

IT IS IMPORTANT TO PERFORM THE FOLLOWING PROCEDURE AS OUTLINED BELOW. THIS WILL KEEP READJUSTMENTS TO A MINIMUM AND PROVIDE OPTIMUM PERFORMANCE.

Ultra-Low NOx Natural Gas Combustion Calibration

- 1. Open the water supply and return valves to the unit and ensure that the system pumps are running.
- 2. Open the natural gas supply valve(s) to the unit.
- 3. Set the control panel **ON/OFF** switch to the **OFF** position
- 4. Turn on external ac power to the unit. The display will show loss of power and the time and date.
- Set the unit to the manual mode by pressing the AUTO/MAN key. A flashing manual valve
 position message will be displayed with the present position in %. Also, the MANUAL LED will
 light.
- 6. Adjust the air/fuel valve position to **0%** by pressing the ▼ arrow key.
- 7. Ensure that the leak detection ball valve downstream of the SSOV is open.
- 8. Set the **ON/OFF** switch to the **ON** position.
- 9. Change the valve position to **30**% using the ▲ arrow key. The unit should begin its start sequence and fire.
- 10. Next, verify that the gas pressure downstream of the SSOV is set to the range of **2.0 ± 0.4**" **W.C.** If gas pressure adjustment is required, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure L-1). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure within the range of **2.0 ± 0.4**" **W.C.**

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual

APPENDIX M - ULTRA-LOW NOx CALIBRATION

BRASS HEAD CAP (Remove to access gas pressure adjustment screw)

TYPICAL SSOV ACTUATOR WITH REGULATOR

Figure M-1. Gas Pressure Adjustment Screw Location

- 11. Using the ▲ arrow key, increase the valve open position to 100%. Verify that the gas pressure on the downstream side of the SSOV settles within the range of 2.0 ± 0.4" W.C. Readjust the gas pressure if necessary.
- 12. With the valve position at 100%, insert the combustion analyzer probe into the flue probe opening and allow enough time for the combustion analyzer reading to stabilize.
- 13. Compare the oxygen readings on the combustion analyzer to the on-board O_2 sensor value displayed in the Operating Menu of the C-More Control Panel. If the values differ by more than $\pm 0.5\%$, have your combustion analyzer calibration checked as soon as possible. If the readings differ by more than $\pm 1.5\%$, use the on-board O_2 sensor to calibrate the unit. Have your combustion analyzer serviced.
- 14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the values shown.

Ultra-Low NOx Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
100%	5% - 7%	<9 ppm	<100 ppm

- 15. If the oxygen level is not within the required tolerance, the gas pressure on the downstream side of the SSOV must be adjusted using the gas pressure adjustment screw on the SSOV (Figure L-1). Slowly rotate the gas pressure adjustment (approximately 1/4-turn increments). Allow the combustion analyzer to stabilize following each adjustment. Clockwise rotation reduces the oxygen level, while counterclockwise rotation increases the oxygen level.
- 16. Once the oxygen level is within the specified range at 100%, record the O₂, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual

APPENDIX M – ULTRA-LOW NOx CALIBRATION

Ultra-Low NOx Natural Gas Combustion Calibration - Continued

NOTE

The remaining combustion calibration steps are performed using the Combustion Cal Menu included in the C-More Control System. The combustion calibration control functions will be used to adjust the oxygen level (%) at valve positions of 80%, 60%, 45%, 30% and 18% as described in the following steps. These steps assume that the inlet air temperature is within the range of 50°F to 100° F. If NOx readings exceed the target value of 9 ppm, increase the O_2 level up to 1% higher than the listed calibration range. Record the increased O_2 value on the Combustion Calibration sheet.

- 17. Lower the valve position to 80% using the ▼arrow key.
- 18. Press the **MENU** key on the front panel of the C-MORE and access the *Setup* menu. Enter password **6817** and then press the **ENTER** key.
- 19. Press the **MENU** key on the front panel of the C-MORE until **Combustion Cal Menu** appears on the display.
- 20. Press the ▲ arrow key until **SET Valve Position** appears on the display.
- 21. Press the CHANGE key. SET Valve Position will begin to flash.
- 22. Press the ▲ arrow key until **SET Valve Position** reads **80%**. Press the **ENTER** key.
- 23. Next, press the down (▼) arrow key until *CAL Voltage 80*% is displayed.
- 24. Press the CHANGE key and observe that CAL Voltage 80% is flashing.
- 25. The oxygen level at the 80% valve position should be as shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the following values:

Ultra-Low NOx Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
80%	5% - 7%	<9 ppm	<100 ppm

- 26. If the oxygen level is not within the specified range, adjust the level using the ▲ and ▼ arrow keys. This will adjust the output voltage to the blower motor as indicated on the display. Pressing the ▲ arrow key increases the oxygen level and pressing the down ▼ arrow key decreases the oxygen level.
- 27. Once the oxygen level is within the specified range at 80%, press the **ENTER** key to store the selected blower output voltage for the 80% valve position. Record all readings on the Combustion Calibration Sheets provided.
- 28. Repeat steps 20 through 27 for valve positions of 60%, 45%, 30% and 18%* (see *NOTE below). The oxygen (O₂), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

*NOTE

Set the Valve Position at 18% but make adjustments to the Combustion Calibration value designated as 16%.

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual

APPENDIX M - ULTRA-LOW NOx CALIBRATION

Ultra-Low NOx Natural Gas Combustion Calibration - Continued

NOTE

If NOx readings exceed the target values shown (<9 ppm), increase the O_2 level up to 1% higher than the listed calibration range shown in the table. Record the increased O_2 value on the Combustion Calibration sheet.

Ultra-Low NOx Combustion Calibration Readings

Valve Position	Oxygen (O ₂) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
60%	5% - 7%	<9 ppm	<100 ppm
45%	5% - 7%	<9 ppm	<100 ppm
30%	5% - 7%	<9 ppm	<100 ppm
18%	5% - 7%	<9 ppm	<100 ppm

- 29. If the oxygen level at the 18% valve position is too high and the Blower voltage is at the minimum value, you can adjust the idle screw (TAC valve) which is recessed in the top of the Air/Fuel Valve (see Appendix G). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O₂ to the specified level. Recalibration MUST be performed again from 60% down to 18% after making a change to the idle screw (TAC valve).
- 30. This completes the ultra-low NOx Natural Gas combustion calibration procedures.

M-2. REASSEMBLY

Once the combustion calibration adjustments are properly set, the unit can be reassembled for service operation.

Reassembly

- 1. Set the **ON/OFF** switch to the **OFF** position.
- 2. Disconnect AC power from the unit.
- 3. Shut off the gas supply to the unit.
- 4. Remove the manometer and barbed fittings and reinstall the NPT plug using a suitable pipe thread compound.
- 5. Remove the combustion analyzer probe from the 1/4" vent hole in the exhaust manifold. Replace the 1/4" NPT plug in the manifold.
- 6. Replace all previously removed sheet metal enclosures on the unit.

LIMITED WARRANTY

BENCHMARK 750 - 6000 GAS-FIRED BOILERS LIMITED WARRANTY:

BENCHMARK 750 - 6000 GAS-FIRED BOILERS

PRESSURE VESSEL/HEAT EXCHANGER: 10 YEAR NON-PRORATED FROM SHIPMENT The pressure vessel/heat exchanger shall carry a 10 year non-prorated, limited warranty from date of shipment against any condensate corrosion, thermal stress failure, mechanical defects or workmanship. Operation of the boiler using contaminated air will void the warranty. The pressure vessel/heat exchanger shall not be warranted from failure due to scaling, liming, corrosion, or erosion due to water or installation conditions. AERCO will repair, rebuild or exchange, at its option the pressure vessel/heat exchanger.

"C-MORE" CONTROL PANEL: 2 YEARS FROM SHIPMENT

AERCO labeled control panels are conditionally warranted against failure for (2) two years from shipment.

OTHER COMPONENTS: 18 MONTHS FROM SHIPMENT

All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment.

The warranty as set forth on the back page of the Operations & Maintenance Manual is in lieu of and not in addition to any other express or implied warranties in any documents, or under any law. No salesman or other representative of **AERCO** has any authority to expand warranties beyond the face of the said warranty and purchaser shall not rely on any oral statement except as stated in the said warranty. An Officer of AERCO must do any modifications to this warranty in writing. **AERCO MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTIES. AERCO** disclaims all responsibility for any special, incidental or consequential damages. Any claim relating to the product must be filed with AERCO not later than 14 days after the event-giving rise to such claim. Any claims relating to this product shall be limited to the sale price of the product at the time of sale. The sale of the product is specifically conditioned upon acceptance of these terms.

CONDITIONS OF WARRANTY:

Should an **AERCO** gas-fired (natural gas, propane, and natural gas/propane dual fuel only) boiler fail for any of the above reasons within the specified time period from the date of original shipment(s), **AERCO** shall at its option modify, repair or exchange the defective item. **AERCO** shall have the option of having the item returned, FOB its factory, or to make field replacements at the point of installation. **In no event shall AERCO be held liable for replacement labor charges** or for freight or handling charges.

AERCO shall accept no responsibility if such item has been improperly installed, operated, or maintained – as defined in the applicable **AERCO** O&M manual, or if the buyer has permitted any unauthorized modification, adjustment, and/or repairs to the item. The use of replacement parts not manufactured or sold by **AERCO** will void any warranty, express or limited.

AERCO shall accept no responsibility if such item has been damaged due to contaminated combustion air containing but not limited to sheetrock particles, plaster board particles, dirt, dust, lint, and corrosive chemicals such as chlorine gas, halogenated hydrocarbons, and Freon.

Continued

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual WARRANTY

In order to process a warranty claim a formal purchase order number is required prior to shipment of any warranty item. In addition, the returned item must include a Returned Goods Authorization (RGA) label, attached to the shipping carton, which identifies the item's return address, register number and factory authorized RGA number.

Warranty coverage for all components and equipment mentioned in said warranty are not valid unless the water heater is started up by a factory certified SST (Service, Start-Up and Troubleshooting) Technician and an **AERCO** start-up sheet is completed.

This warranty coverage is only applicable within the United States, Canada and Mexico. All other geographical areas carry a standard warranty of 18 months from date of shipment or 12 months from startup, whichever comes first.

Rev. 11/22/2013

NOTES:

Benchmark 750/1000 Boiler Installation, Operation & Maintenance Manual

Change Log:

Date	Description	Changed By
03/19/2014	Rev I: PIR 780: replaced mechanical latch with magnetic PIR 981: Expanded Table A in Appendix F Part List PIR 934-33: Modified step 13 in Combustion Calibration regarding defective O ₂ Sensor. PIR 934-37: Modified Blocked Inlet Switch Test instructions, section 6.8.2. PIR 960: Addition of two sub-sections in 2.10.12; addition of section 2.15 Sequencing Isolation Valve Installation; 3.9 _BST Menu; addition of Chapter 10 - Boiler Sequencing Technology; replaced all wiring schematics in Appendix I, addition of 24V Sequencing Valve & Flame Rod Amplifier. PIR 974: Replaced Gas train harness 161450 with 63147 in Appendix G. PIR 1000: P/N 61026 now labeled "Lean Oxygen Sensor," 64081 now named "ECU" PIR 1005: Changed 12 Month Maintenance Kit part number to 58025-01	Chris Blair
PIR 749: Added Propane to section 2.8 Gas supply Piping; new Propane combustion calibration section 4.4; modified sections 6.2 & 6.3; added Propane gas train 22140-3 drawings to Appendix G. PIR 934-65: Added explanatory paragraph & note to section 2.15 – Sequencing Isolation Valve Installation		Chris Blair



© AERCO International, Inc., 2014